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Washington Public Ports Association

Washington State Marine Terminal AKART and ISGP Corrective Action Guidance Manual

December 2014

Prepared for

Washington Public Ports Association
1501 Capitol Way
Olympia, Washington 98507-1518

K/J Project No. 1396032.00

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Acknowledgements

In partnership with the Washington State Department of Ecology (Ecology) and external stakeholders, the Washington State Public Ports Association (WPPA) has performed an All Known, Available, and Reasonable methods of prevention, control, and Treatment (AKART) study, described herein, outlining stormwater operational and structural source control and treatment best management practices suited for Washington State marine terminals. To inform the process, WPPA engaged sector-specific work groups, including marine terminal operators (MTOs) and the Pacific Merchant Shipping Association representing container terminal MTOs. WPPA also invited representative environmental organizations with an interest in water quality and marine commerce, including Puget Soundkeeper Alliance, Washington Environmental Council, and Citizens for a Healthy Bay, to engage in the study process.

WPPA and its member ports would like to specifically recognize Ecology for its collaboration and commitment during development of the Washington State Marine Terminal AKART and ISGP Corrective Action Guidance Manual (Manual), as well as the agency's recognition, included in the attached letter from Ecology's Director, that facilities following the pathways to compliance in the Manual will have implemented AKART to the extent required by Washington State standards.

Contributing member organizations include:

Ann K. Farr Environmental Management Consulting Services
APM Terminals Tacoma
Citizens for a Healthy Bay
Eagle Marine Services (Port of Seattle Terminal 5)
Floyd|Snider
Herrera Environmental Consultants
Husky Terminal and Stevedoring Tacoma
Kennedy/Jenks Consultants
KPFF Consulting Engineers
Northland Services/Alaska Marine Lines (Port of Seattle Terminal 115)
Pacific Merchant Shipping Association
Pierce County Terminal Tacoma
Port of Bellingham
Port of Everett
Port of Grays Harbor
Port of Olympia
Port of Port Angeles
Port of Seattle
Port of Tacoma
Puget Soundkeeper Alliance

Stevedoring Services of America (Port of Seattle Terminal 18, Terminal 25, Terminal 30)
Total Terminals International (Port of Seattle Terminal 46)
Totem Ocean Trailer Express Tacoma
Washington Environmental Council
Washington Public Ports Association
Washington State Department of Ecology
Washington United Terminal Tacoma

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May 23, 2014

Mr. Eric Johnson, Executive Director
Washington Public Ports Association
1501 Capitol Way, Suite 304
Olympia, WA 98501

RE: Washington Public Ports Association Stormwater Guidance Manual

Dear Mr. Johnson:

I am writing to convey my appreciation to the Washington Public Ports Association's (WPPA) leadership in developing the *Washington Public Ports Association Washington State Marine Terminal AKART and ISGP Corrective Action Guidance Manual Public Review Draft* (Manual). The collaborative approach used to develop the Manual is a model that should be considered by other facility types regulated under the Industrial Stormwater General Permit (ISGP) as they seek to achieve compliance. The commitment of WPPA's members to fully implement the requirements of the ISGP is invaluable, and is further evidence of the commitment public ports make to improve the health of our state's environment.

Department of Ecology (Ecology) specifically notes the following features of the Manual:

- The identification and endorsement of stormwater best management practices (BMPs) relevant to the types of activities that occur at marine terminals.
- The flowchart depicting the pathway to ISGP compliance and All Known Available and Reasonable methods of Treatment (AKART) through the ISGP's adaptive management process, along with the accompanying text.
- The concentration-based and facility-specific approaches to selecting appropriate stormwater treatment practices providing facilities the flexibility to choose treatment options that best fit their circumstances.
- The discussion of available stormwater treatment methodologies designed to reduce pollutants in stormwater discharges from marine terminals in Washington State.

Furthermore, a facility that follows the pathway to compliance and receives Ecology approval of the facility's chosen stormwater treatment approaches (through approval of Engineering Reports prepared in accordance with Ecology guidelines, as required), will be understood to have implemented AKART to the satisfaction of Washington State standards.

Ecology commends the WPPA, and its member ports for their good faith efforts to comply with ISGP requirements, and for actively engaging Ecology to develop the Manual. We also applaud the valuable input from key advocacy groups for both industry and the environment during the development of the Manual including: marine terminal operators, the Pacific Merchant Shipping Association, Puget Soundkeeper Alliance, Washington Environmental Council, and Citizens for a Healthy Bay. We look forward to working with WPPA and the Washington port community stakeholders to implement and update the Manual to ensure that it continues as a relevant and useful tool marine terminals use to effectively manage stormwater in compliance with the ISGP.

Sincerely,

Maia D. Bellon
Director

cc: Chris Wilke, Puget Soundkeeper Alliance
Bill Anderson, Citizens for a Healthy Bay
Darcy Nonemacher, Washington Environmental Council

Section 1: Purpose and Applicability

1.1 Purpose

Washington's public ports, represented by the Washington Public Ports Association (WPPA), are collaborating to develop stormwater management solutions that both protect water quality and fulfill Washington State Department of Ecology (Ecology) Industrial Stormwater General Permit (ISGP) requirements in a cost-effective and fiscally responsible manner. Due to the unique nature of marine terminal operations, Washington's public marine ports face common, significant technical challenges in meeting current ISGP benchmarks and are exploring ways to reduce operational and financial uncertainties associated with stormwater management.

Marine terminal facilities are unique as compared to other industrial facilities, because they are expansive, fully utilized properties located adjacent to tidally influenced waterways at the urbanized base of watersheds. Marine terminal facilities typically exhibit little topographic relief and opportunities for application of gravity-based stormwater treatment solutions are often limited within established drainage systems.

Stormwater discharges from many industrial marine terminals are regulated by Ecology under the ISGP. The ISGP requires the implementation of best management practices (BMPs) to comply with Washington State water quality standards, Washington State All Known, Available, and Reasonable methods of prevention, control, and Treatment (AKART), and federal technology-based treatment requirements. The ISGP defines benchmark values for pollutant levels for stormwater discharges and uses the benchmark values specified in the ISGP as indicators of pollutants that need further reduction. The ISGP requires additional treatment of stormwater when operational and structural source control BMPs are not adequate to reduce pollutants below a benchmark value. Permittees who measure benchmark exceedances must complete corrective actions, which may include implementation of additional operational and structural source control BMPs (Level 1 and 2 Corrective Actions) and installation of stormwater treatment (Level 3 Corrective Actions).

In partnership with Ecology and external stakeholders, WPPA has performed an AKART study, described herein, that outlines operational and structural source control and treatment BMPs suited for Washington State marine terminal operations and provides a clarified ISGP compliance pathway for marine terminal facilities.

The primary goals of the WPPA Washington State Marine Ports AKART study include:

- Provide a clear definition of AKART as it applies to stormwater approaches to be applied at Washington State marine terminals.
- Identify operational and structural source control BMPs and recommended corrective actions specific to Washington marine terminals, including container terminals, bulk and break bulk terminals, and waterfront log yards located on public port properties in Washington State (addressed in Appendices A and B).

- Identify appropriate stormwater treatment approaches for marine terminals that meet ISGP Level 3 Corrective Action requirements and may be appropriate to reduce pollutant levels in stormwater discharges below ISGP benchmarks (addressed in Appendix C).

- Provide guidance for marine terminal operators (MTOs) to identify sources of pollutants at their facilities and clearly identify source control practices that are effective within marine terminal settings (addressed in Appendix D).

- Provide pathways for achieving State water quality goals while reducing compliance uncertainties for marine terminal operations at Washington State public ports.

The resultant efforts of the study have been incorporated in this Washington State Marine Terminal AKART and ISGP Corrective Action Guidance Manual (Manual).

This Manual is intended to work in concert with the ISGP without changing the permit requirements. This Manual augments Ecology's Stormwater Management Manual for Western Washington (SWMMWW) providing guidance for marine terminal BMPs and evaluation criteria for incorporation into facility-specific Stormwater Pollution Prevention Plans (SWPPPs) and engineering reports.

This document is intended as guidance only and does not modify or otherwise change the requirements of the ISGP. If there is any discrepancy between this guidance and the ISGP, the ISGP requirements supersede this guidance.

1.2 Defining AKART at Washington State Marine Terminals

Ecology has defined AKART to represent "the most current methodology that can be reasonably required for preventing, controlling, or abating the pollutants associated with a discharge" (WAC 173-201A-020). Ecology has provided guidance on how to implement AKART in the Water Quality Program's Permit Writer's Manual (PWM). According to the PWM, AKART is a technology-based approach to limiting pollutants in facility discharges. At the federal level, the U.S. Environmental Protection Agency (EPA) has also determined that BMPs to control stormwater discharges constitute Best Available Technology (BAT) economically achievable and Best Conventional Technology (BCT), the federal counterpart to AKART.

For stormwater, implementation of BMPs is the primary means by which Ecology requires compliance with AKART [WAC 173-201A-160(3)]. Ecology's policy is that "[t]he [Stormwater] Manual, or other stormwater technical guidance documents approved by Ecology, are intended to provide project proponents, regulatory agencies and others with technically sound stormwater management practices which are presumed to protect water quality and satisfy the Washington State AKART requirement." (Washington State Register 03-15-091, July 2003).

Typically, an AKART determination is a site-specific analysis, which applies appropriate BMPs from available Ecology manuals to address conditions at a particular facility. Ecology has implemented a process by which new and emerging technologies are evaluated and considered to be appropriate for inclusion into Ecology manuals. AKART represents a technology-based approach for limiting pollutants from discharges that weighs both engineering and economic considerations to determine the most appropriate level and method of treatment.

A key term in the definition of AKART is "reasonable." Reasonableness for a facility-specific stormwater treatment approach is dependent on a variety of factors including; site constraints and implementability, effectiveness of pollutant removal, reliability, and consistent performance. The cost and the affordability of construction, operation, and maintenance are also considered. Specific considerations in determining reasonableness include:

- The ability for particular stormwater treatment approaches to reduce the concentration of pollutants of concern in stormwater, including the ability to provide suitable treatment under the range of flows and conditions anticipated at a facility.
- Reliability and consistent performance.
- The practicability of construction, operation, and maintenance of the treatment approach given the existing infrastructure and operations at a particular facility.
- The cost of design, construction, operation, and maintenance.
- Non-water quality environmental impacts.

Although the nature of the marine terminals is often similar, site-specific differences between facilities affect the characteristics of stormwater and the reasonableness of implementing stormwater treatment. The information in this document is intended to be a resource for marine terminal owners and operators in identifying sources of pollutants, and defining operational and structural source control BMPs and stormwater treatment approaches that are likely to be effective and reasonable for implementation.

This Manual proposes what operational and structural source control BMPs and stormwater treatment approaches may be considered to represent AKART for stormwater management at typical marine terminals. It also defines a process that marine terminals can implement to determine AKART on a facility-specific basis if their facility is atypical or if implementation of identified treatment technologies will present economic hardship that threatens the viability of the facility.

1.3 Applicability

This Manual applies to four broad categories of port and tenant operations at Washington public port facilities draining to marine and estuarine receiving waters required to seek coverage under the ISGP. These categories represent characteristics, activities, and land uses common at large and small Washington public port marine terminal facilities and are intended to be used for guidance by ports and MTOs at the following types of Washington State marine terminals:

- Container Terminals.
- Break Bulk Terminals – Roll on/roll off (Ro/Ro) facilities and other operations for commodities not commonly transported by container.
- Dry Bulk Terminals – Grains, soy, and other commodities.
- Waterfront Log Yards.

Many of the marine terminals in Washington State, handling the commodities identified in these general categories, are considered to fall under Standard Industrial Classification (SIC) major group 44XX – Water Transportation. Waterfront log yards often are categorized under SIC code 2411 – Logging.

1.3.1 Container Terminals

Container terminals are large waterfront terminals where shipping containers are transloaded from ship to truck and rail. Almost all container terminals are operated by MTOs that lease terminal property from the local port authority. At these facilities, the MTOs are typically the ISGP holders and responsible parties for stormwater management and ISGP compliance.

1.3.2 Break Bulk Terminals

In shipping, break bulk cargo or project cargo includes goods that are shipped individually as opposed to within shipping containers or in bulk as with oil or grain.

1.3.3 Dry Bulk

Bulk cargo is commodity cargo transported unpackaged in large quantities generally classified as liquid or dry. Marine terminals that handle dry bulk materials are the focus in this Manual for the bulk cargo category.

Dry bulk terminals include berths at marine ports that are used to transfer dry bulk materials between truck, barge or rail, and ships. Dry bulk materials may include mineral ores (metal concentrates, pelletized or fine iron ore), coal, industrial minerals and chemicals (potash, soda ash, bauxite, clay, sand, gravel, limestone, salt), industrial products (petroleum coke, calcined petroleum coke), agricultural products (grains including wheat, soy, corn, etc.), non-grain food products or chemicals (sugar, flour), and miscellaneous bulk materials (shredded scrap steel, wood pellets, wood chips).

1.3.4 Waterfront Log Yards

The waterfront log yards considered in this Manual are marine terminals at public ports draining to marine/estuarine waters where cut logs are delivered in bulk by truck or rail, temporarily stockpiled on the terminal, and then transloaded to ships for export. Activities on waterfront log yards can include log storage, rollout, sorting, scaling and cutting; log stacking and loading, debarking, and storage of wood debris and loading equipment.

1.4 Stormwater Pollutants of Concern

The ISGP pollutants measured to be of most concern at many Washington State marine terminals include zinc, copper, and turbidity. Additionally, waterfront log yards are also required to monitor for total suspended solids (TSS) and chemical oxygen demand (COD). Several of these parameters have become problematic for marine terminals to control. Table 1 provides summary statistics compiled from Ecology's discharge monitoring report database for the primary marine terminal SIC codes including 2411 – Logging, and major group 44XX – Water Transportation, representing the majority of water transportation categories.

Table 1: Summary of ISGP Submitted Water Quality Data 2010-2013 for Select Marine Terminal Standard Industrial Classification (SIC) Codes

SIC 2411 (Logging)

Parameter	Units	Benchmark Value	Mean	Min	10th %ile	25th %ile	Median	75th %ile	90th %ile	Max	No. Obs	No. Above BM
Chemical Oxygen Demand (COD)	mg/L	120	246.8	0.2	8	27	89	328	698	3300	829	361
Copper	µg/L	14	14.4	0.004	2	2.4	6.24	12.2	28	485	824	175
Total Suspended Solids	mg/L	100	82.3	0.5	5	10	27	77	190	3070	812	148
Turbidity	NTU	25	83.6	0.4	3.5	10	24.9	75.1	194	2288	875	430
Zinc	µg/L	117	103.7	0.003	6.2	14	43.5	99.3	212	2400	851	163

SIC 44XX (Water Transportation)

Parameter	Units	Benchmark Value	Mean	Min	10th %ile	25th %ile	Median	75th %ile	90th %ile	Max	No. Obs	No. Above BM
Copper	µg/L	14	30.5	0.45	2.1	5.7	13	26.1	53.02	1640	1702	787
Turbidity	NTU	25	52.3	0.1	2.97	6.5	15.3	38.5	101	3000	1644	562
Zinc	µg/L	117	223.0	0.04	16	53	129	280	480	4330	1748	927

*Data represents Ecology's database records for the industrial SIC codes listed for 2010 through 2013.
Only the ISGP parameters measured to be of most concern for the SIC group identified are listed.

Notes:

mg/L = milligrams per liter
µg/L = micrograms per liter
NTU = Nephelometric turbidity units

Section 2: Implementing AKART and Corrective Actions at Marine Terminals

The following narrative and companion flowchart at the end of this section introduces the process for implementing AKART and corrective actions at Washington State marine terminals in accordance with the ISGP and Washington State law.

2.1 Compliance Process Narrative

This section provides a narrative description, listed in sequential order by activity or situation, of what is set out in the flowchart. For ease of reference, each box or diamond in the flowchart has been assigned a number corresponding to the numbered detail below describing that activity or situation. Also provided within this narrative is reference to relevant sections of this Manual that are pertinent to that activity or situation.

1. AKART compliance requires implementation of operational and structural source control and select treatment BMPs specified in the ISGP (including references to various manuals). The ISGP and manual-specified applicable BMPs (listed in Appendix A) are mandatory, and all Permittees must implement these BMPs as a condition to operating under the ISGP.

2. If a facility is fully implementing a SWPPP that includes all applicable (mandatory) BMPs from the ISGP, SWMMWW, and other applicable guidance documents, and if benchmarks are achieved, the Permittee is presumed to have implemented AKART, and no further actions are required other than continuing to meet the requirements of the ISGP. Go to Box 3.

3. Specifically, the ISGP states the following with regard to Permittee's compliance with Washington State water quality standards:

   Ecology will presume compliance with water quality standards, unless discharge monitoring data or other site-specific information demonstrates that a discharge causes or contributes to violation of water quality standards, when the Permittee is:

   1. *In full compliance with all permit conditions, including planning, sampling, monitoring, reporting, and recordkeeping conditions.*

   2. *Fully implementing storm water best management practices contained in storm water technical manuals approved by the department, or practices that are demonstrably equivalent to practices contained in storm water technical manuals approved by Ecology, including the proper selection, implementation, and maintenance of all applicable and appropriate best management practices for on-site pollution control.*

4. If quarterly sample results exceed any applicable benchmark value, the facility will trigger Level 1 Corrective Actions (Operational Source Control BMPs). Level 2 Corrective Actions (Structural Source Control BMPs) are triggered by exceeding an applicable benchmark value (for a single parameter) for any 2 quarters in a calendar year. Deadlines for implementation of Level 1 and Level 2 Corrective Actions are defined in the ISGP. Recommendations for Level 1 and Level 2 BMPs that are

appropriate for consideration at marine terminals are discussed in Section 3 and Appendix B of this Manual.

5. If quarterly sample results exceed benchmark levels for a single parameter 3 or more quarters in a calendar year, the facility will trigger Level 3 Corrective Actions and the Permittee is required to implement stormwater treatment. Some important Level 3 Corrective Action deadlines are paraphrased below. Please note that the milestone dates listed are derived from the ISGP in effect at the time of publication of this Manual. To maintain the relevance of this Manual, the below dates should be considered to be those defined in the version of the ISGP that is current at the time Level 3 Corrective Actions are triggered:
   a. Permittees proposing to install stormwater treatment BMPs that require the site-specific design or sizing of structures, equipment, or processes to collect, convey, treat, reclaim, or dispose of industrial stormwater must submit an Engineering Report to Ecology for review in accordance with Chapter 173-240 WAC, **no later than May 15th prior to the Level 3 deadline**, unless an alternate due date is specified in an order.
   b. Permittees must submit plans, specifications, and an operation and maintenance (O&M) manual to Ecology **at least 30 days before construction/installation**, unless an alternate date is specified in an order.
   c. Permittees must fully implement the stormwater treatment approach included in their Ecology-approved Engineering Report as soon as possible, but **not later than September 30th** of the year following year following the calendar year during which the Level 3 Corrective Actions were triggered, unless an alternate date is specified in an order.

   Permittees also have the option to request a time extension or waiver from installation of stormwater treatment through the public process of requesting a Modification of Permit Coverage **by May 15th prior to the Level 3 Corrective Action deadline** if a Permittee believes that installation of treatment BMPs is not feasible or not necessary to prevent discharges that may cause or contribute to violation of a water quality standard.

6. Permittees at the Level 3 Corrective Action stage will compare the level of pollutants measured in runoff to concentration ranges specified in Section 4 of this Manual. For each pollutant or grouping of pollutants, treatment approaches with the potential capability to reduce pollutant concentrations to benchmark levels are listed in the tables included in Appendix C. In general, stormwater treatment becomes more complex and costly as pollutant concentrations increase.

7. The Permittee will make a qualitative and quantitative assessment of the stormwater treatment technologies listed in the Appendix C tables to establish which stormwater treatment approach(es) is appropriate and reasonable to implement at their facility assisted by the decision-making criteria described in Section 5. If a Permittee believes that the identified stormwater treatment approaches for the concentration of pollutants at its facility are not appropriate or reasonable to implement, they have the option to conduct a facility-specific evaluation, described in Section 6.

8. Permittees conducting a facility-specific evaluation will be required to document why the listed concentration-based stormwater treatment approaches are not reasonable to implement at their facility and to define the maximum reasonable treatment approach that is appropriate based on their specific terminal characteristics and economic situation. Such documentation can include evidence that the Permittee's facility is atypical coupled with documentation of the results of a facility-specific reasonableness evaluation described in Section 6.

9. The Permittee will prepare an engineering report for submittal to Ecology describing the evaluations performed and Level 3 Corrective Actions proposed based on their concentration-based or facility-specific evaluation. The engineering report must propose selected stormwater treatment approaches that a professional engineer believes to have a reasonable likelihood of meeting applicable benchmark(s) in future facility discharges and to verify that AKART has been or will be achieved in accordance with the Level 3 deadlines defined in the ISGP. Ecology concurrence of stormwater treatment approach must be secured before implementing the proposed Level 3 Corrective Actions, i.e., construction/installation cannot commence until Ecology approves the engineering report.

10. With Ecology approval, the identified treatment approach(es) will be implemented. AKART will then be assumed to have been achieved for the facility provided that that all applicable operational and structural source control BMPs are also being implemented and all other ISGP conditions are being met.

11. Following implementation of the Ecology-approved stormwater treatment approach, the Permittee will continue monitoring as required by the ISGP. If benchmarks are met, no further treatment will be required.

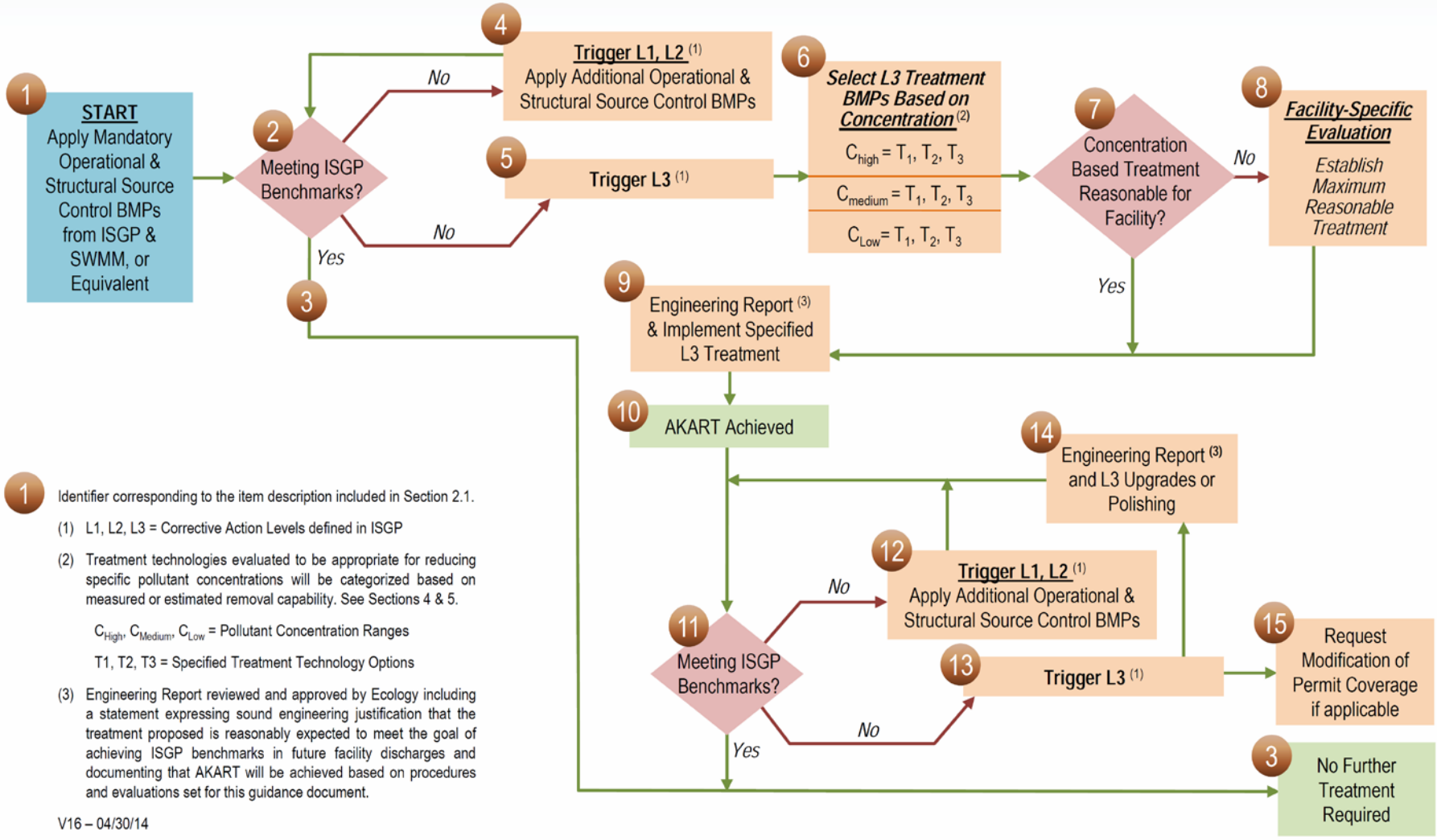
12. If quarterly sample results exceed applicable benchmark levels, as defined in step 4 above, after implementing Level 3 treatment BMPs, the facility will trigger additional Level 1 and Level 2 Corrective Actions.

13. If a Permittee triggers another Level 3 Corrective Action following implementation of stormwater treatment meeting Washington State AKART standards, they will need to evaluate whether additional treatment BMPs or treatment upgrades can be implemented with the goal of achieving ISGP benchmark levels in future facility discharges.

14. Permittees may engage Ecology to determine whether the treatment facility installed under the previous Level 3 can be upgraded to more effectively treat stormwater. Stormwater treatment system upgrades are anticipated to include modification of the existing treatment system, including additional upgrades and/or potential structural additions. In some cases, the existing treatment system may be augmented by a pre-treatment or polishing step (i.e., expanded treatment train). The Permittee's plans for treatment system upgrades must to be submitted to Ecology for review and approval in an engineering report.

15. If a Permittee believes that additional treatment is not feasible or not necessary to prevent discharges that may cause or contribute to a violation of a water quality standard, a Permittee may request a waiver from further treatment through the public process of obtaining a Modification of Permit Coverage along with a detailed technical basis for the request, in accordance with ISGP requirements. If the waiver request relies on mixing or dilution, the request must explain how AKART has been achieved based on stormwater treatment previously installed in accordance with an Ecology-approved engineering report.

WPPA Washington State Marine Terminal AKART & ISGP Corrective Action Pathway



1 Identifier corresponding to the item description included in Section 2.1.

(1) L1, L2, L3 = Corrective Action Levels defined in ISGP

(2) Treatment technologies evaluated to be appropriate for reducing specific pollutant concentrations will be categorized based on measured or estimated removal capability. See Sections 4 & 5.

C_{High}, C_{Medium}, C_{Low} = Pollutant Concentration Ranges

T1, T2, T3 = Specified Treatment Technology Options

(3) Engineering Report reviewed and approved by Ecology including a statement expressing sound engineering justification that the treatment proposed is reasonably expected to meet the goal of achieving ISGP benchmarks in future facility discharges and documenting that AKART will be achieved based on procedures and evaluations set for this guidance document.

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Section 3: Operational and Structural Source Control BMPs for Marine Terminals

3.1 Applicable (Mandatory) Operational and Structural Source Control BMPs

The ISGP requires Permittees to conduct a detailed facility review to identify pollutant sources during development of their SWPPP. A comprehensive site evaluation will help Permittees to most effectively target pollutants with operational and structural source control BMPs.

Permittees are required to implement certain operational and structural source control BMPs and treatment BMPs that are specified in the ISGP or included by reference in other approved manuals. The manuals identify BMPs that are "applicable" to all Permitees or to a particular activity that is performed by specific Permittees. Individual "applicable" BMPs are mandatory and must be implemented unless site conditions render the BMP unnecessary, infeasible, or the Permittee provides alternative and equally effective BMPs (clear justification for each BMP omission must be documented in the facility SWPPP). Permittees must modify the SWPPP if the owner/operator or the applicable local or state regulatory authority (Ecology) determines during inspections or investigations that the SWPPP is, or would be, ineffective in eliminating or significantly minimizing pollutants in stormwater discharges from the site.

For each of the four categories of marine terminals considered in this Manual, applicable (mandatory) BMPs are summarized in Appendix A. The BMPs are organized by reference (e.g., ISGP, ISGP Implementation Manual for Log Yards, SWMMWW, other guidance manual or source, etc.) and marine terminal type (container, log yard, break bulk, bulk). Not all applicable BMPs in the SWMMWW and other potentially appropriate guidance documents have been included in Appendix A and it is the Permittee's responsibility to ensure that all applicable BMPs are included in the facility SWPPP and that ISGP conditions are satisfied. Some BMPs are appropriate to implement facility-wide (i.e., good housekeeping, training) while some BMPs are activity specific (i.e., fueling) and are intended to be implemented where that activity occurs. Additional source evaluation (described in Appendix D) is recommended, including sampling upstream of discharge locations to better characterize pollutant source areas. Areas with the potential to contribute the highest pollutant loadings to stormwater require particular attention and focused BMP implementation.

3.2 Recommended Operational and Structural Source Control BMPs

Permittees are recommended to also consider implementing operational and structural BMPs that are not defined to be applicable (mandatory), but may improve stormwater quality at their facility. Recommended BMPs are provided in the appropriate guidance manuals and BMPs identified by MTOs that may be particularly useful for marine terminal Permittees to address ISGP Level 1 (operational source control) and Level 2 (structural source control) corrective action requirements are discussed below and listed in Appendix B.

3.2.1 Ecology Recommended Operational and Structural Source Control BMPs

The SWMMWW includes several "recommended" operational and structural source control BMPs described as approaches that go beyond or complement the applicable (mandatory) BMPs. The SWMMWW states that "facilities covered under the ISGP who trigger a corrective action should consider implementing one or more recommended BMPs as a means to fulfill their corrective action requirements and achieve benchmark values". Ecology-recommended BMPs can be found within the individual BMP descriptions included in the SWMMWW.

3.2.2 Industry-Developed Recommended Operational and Structural Source Control BMPs

Additional BMPs that have been implemented at Washington State marine terminals to improve stormwater quality with specific descriptions and guidance for implementation are described in Appendix B.

3.3 Operational and Structural Source Control BMPs for Level 1 and Level 2 Corrective Actions

This section discusses the ISGP requirements for Level 1 and Level 2 Corrective Actions and potential operational and structural source control BMPs that may be considered for implementation to improve stormwater quality.

3.3.1 ISGP Level 1 and Level 2 Requirements

Even after implementing the applicable (mandatory) BMPs referenced in the ISGP and appropriate guidance documents, including this Manual, Permittees may still find that stormwater discharges from their facility exceed ISGP benchmark values. Each time a benchmark is exceeded, a Permittee must implement a Level 1 Corrective Action. Level 1 Corrective Actions include the following paraphrased requirements (see the ISGP for a complete listing):

- Conduct a facility inspection to investigate the cause of the benchmark exceedance.
- Review the SWPPP and ensure that it fully complies with ISGP conditions, and that it contains the correct BMPs from the appropriate guidance documents.
- Make appropriate revisions to the SWPPP to include additional operational source control BMPs with the goal of achieving the benchmark value(s) in future discharges.

Permittees that exceed a benchmark value (for a single parameter) for any 2 quarters during a calendar year shall complete a Level 2 Corrective Action, which includes the following (see the ISGP for a complete listing of Level 2 Corrective Action requirements):

- Make appropriate revisions to the SWPPP to include additional structural source control BMPs with the goal of achieving the benchmark value(s) in future discharges.

3.3.2 Specific ISGP Level 1 and Level 2 Corrective Action Recommendations

This subsection provides guidance for implementing operational and structural source control BMPs in response to ISGP Level 1 and Level 2 Correction Action requirements building on the guidance for implementing applicable (mandatory) BMPs from the previous subsection. The ISGP corrective action process is intended to promote adaptive management, where Permittees implement actions, review subsequent monitoring data, and continue application of BMPs until benchmarks are achieved. Due to the time constraints in the ISGP, Permittees are encouraged to consider additional monitoring to rapidly assess BMP effectiveness so that additional BMPs can be targeted and adapted for maximum water quality benefit.

As part of responding to a Level 1 or Level 2 Corrective Action, Permittees are recommended to review all mandatory, recommended, and otherwise appropriate BMPs to determine if they have been fully implemented. Initial actions may include:

- Evaluate whether BMPs that have already been implemented at the facility could be implemented more effectively, widely, or frequently.
- Consider implementing recommended BMPs included in Appendix B.
- Perform additional source characterization including considering additional sampling to determine success at controlling sources (more frequently than required by the ISGP) at locations nearer to potential sources (see Appendix D).

Additional source characterization is recommended, particularly if the sources of pollutants triggering the corrective action are not well defined. Once source areas have been identified, Permittees are encouraged to target additional operational and structural source control BMPs in areas causing the most significant stormwater pollutant impact, as close to the source as possible to limit pollutants to stormwater discharges.

Section 4: Level 3 Stormwater Treatment Approaches

This section summarizes ISGP Level 3 Corrective Action requirements and includes descriptions of stormwater treatment approaches for consideration at Washington State marine terminals. A comprehensive listing of stormwater treatment approaches, including proprietary and non-proprietary stormwater treatment equipment and methods from various sources, including the SWMMWW, Ecology's Technology Assessment Protocol Ecology (TAPE) program, and other useful references (e.g., California Department of Transportation BMP Technology Report, Ecology's Stormwater Treatment Technology Literature Review) are included in Appendix C. The stormwater treatment approaches listed in Appendix C may not include all available treatment approaches that exist and Permittees are encouraged to perform additional research to identify effective stormwater treatment approaches that may be appropriate for their particular facility and operations. In general, applying near-source stormwater treatment BMPs on a basin by-basin approach is recommended.

This section also provides an analysis that Permittees can use to evaluate the appropriateness of the various listed stormwater treatment methods for marine terminal facilities. The goal is to facilitate Permittee evaluation of treatment technologies, by considering individual facility conditions that are common at marine terminals and the required level of treatment for specific pollutant concentrations. Permittees should consider the information provided in this section and the listing of treatment approaches included in Appendix C in conjunction with the information included in Section 5 (AKART Stormwater Treatment Selection Methodology) to establish the treatment approaches considered to be appropriate at their individual facilities and that meet the ISGP requirements.

4.1 ISGP-Required Level 3 Stormwater Treatment Approaches

Permittees that exceed a benchmark value (for a single parameter) for any 3 quarters during a calendar year are required to complete Level 3 Corrective Actions including but not limited to the following (see the ISGP for a complete listing):

- Make appropriate revisions to the SWPPP to include additional stormwater treatment approaches with the goal of achieving the benchmark value(s) in future discharges. Additional operational and/or structural source control BMPs may also be necessary for proper performance and maintenance of stormwater treatment approaches.

- Before installing stormwater treatment that requires the site-specific design or sizing of structures, equipment, or processes to collect, convey, treat, reclaim, or dispose of industrial stormwater, the Permittee is required to submit an engineering report, plans and specifications, and an operation and maintenance (O&M) manual to Ecology for review in accordance with Chapter 173-240 WAC.

If a Permittee believes that installation of stormwater treatment is not feasible at their facility or not necessary to prevent discharges that may cause or contribute to violation of a water quality standard, Permittees may request a time extension or waiver from the Level 3 Corrective Action requirements. Ecology may consider a Modification of Permit Coverage in accordance with specific conditions and requirements listed in the ISGP.

4.2 Identification of Candidate Treatment Approaches

A broad range of candidate stormwater treatment approaches for potential application in meeting ISGP Level 3 Corrective Action requirements at Washington State marine terminals were identified and listed in Appendix C from the following resources:

SWMMWW: This manual identifies design criteria and performance goals for stormwater BMPs in the State of Washington. The ISGP requires treatment of stormwater runoff from industrial activities to be consistent with this Manual. However, several of the BMPs identified in the SWMMWW were developed to comply with presumptive municipal new development and redevelopment requirements and may not be appropriate for marine terminal applications due to common site constraints and the typically higher pollutant concentrations common at these facilities.

The SWMMWW advises that project proponents have the option not to follow the stormwater management practices in the manual. However, project proponents may be required to individually demonstrate that BMPs selected are "demonstrably equivalent." Demonstrably Equivalent means that the technical basis for the selection of all stormwater BMPs is documented within a SWPPP. The SWPPP must document: 1) The method and reasons for choosing the stormwater BMPs selected; 2) The pollutant removal performance expected from the practices selected; 3) The technical basis supporting the performance claims for the practices selected, including any available existing data concerning field performance of the practices selected; 4) An assessment of how the selected practices will comply with Washington State water quality standards; and 5) An assessment of how the selected practices will satisfy both applicable federal technology-based treatment requirements and state requirements to use all known, available, and reasonable methods of prevention, control, and treatment.

Technology Assessment Protocol – Ecology (TAPE): TAPE provides a peer-reviewed regulatory certification process for emerging stormwater treatment technologies applicable under municipal treatment applications. The TAPE program is administered by Ecology with assistance from staff at the Washington Stormwater Center. Depending on the relevance, quantity, and quality of performance data provided with the application for certification, Ecology will place technologies entering the program into one of two use level designation categories: pilot use level designation (PULD) or conditional use level designation (CULD). The PULD and CULD allow the technology to be installed and operated in the State of Washington in order to gather the performance data required for final general use level designation (GULD) certification under the municipal permit program. Technologies that receive a GULD certification are approved for widespread use in Washington to meet the presumptive stormwater treatment requirements triggered under municipal stormwater general permit minimum requirements for new development and redevelopment.

It must be reinforced that the ISGP is a demonstrative permit in that exceeding permit benchmarks in facility discharges may trigger Level 3 Corrective Actions including stormwater treatment. GULD certification does not constitute Ecology approval or endorsement of a specified stormwater treatment approach at industrial facilities. GULD certified treatment approaches have, however, been demonstrated to reduce pollutant levels by a specified percentage depending on pollutant-given documented influent characteristics and therefore, may be helpful to consider for use at industrial facilities.

Emerging technologies that are currently in the TAPE program and their use level designations are posted on Ecology's Emerging Technologies website at: www.ecy.wa.gov/programs/wq/stormwater/newtech/index.html. The PULD, CULD, and GULD designation for specific stormwater treatment technologies are listed in Table C-2 in Appendix C.

Literature Review of Existing Treatment Technologies for Industrial Stormwater: A literature review was performed in 2011 by Herrera Environmental Consultants (Herrera) to support Ecology's source control efforts in the Lower Duwamish Waterway. The review primarily focused on proprietary stormwater treatment technologies that are not listed in the SWMMWW. Information on a total of 91 passive and 18 active systems for treating industrial or municipal stormwater was compiled during this review. For each treatment technology evaluated in the report, available information was summarized under the following general categories: vendor information, treatment performance, system design, and installation and O&M costs. Guidance on the appropriate application(s) for the treatment technologies was also provided.

Caltrans Treatment BMP Technology Report: This report was prepared by the California Department of Transportation (Caltrans) in 2008 to identify and evaluate treatment BMP technologies for potential use in the highway environment in California. It presents facts sheets that summarize available design, construction, and performance information on 13 Caltrans-approved and 29 unapproved stormwater treatment BMPs. Specific treatment approaches were approved by Caltrans based on the quality of available performance data and their applicability for use in highway environments.

ISGP Engineering Reports: Additional treatment BMPs were considered based on review of approved engineering reports that have been prepared for select Washington marine terminals in response to ISGP Level 3 Corrective Action requirements including:

- *Port of Olympia Marine Terminal Stormwater Treatment Engineering Report*
- *Port of Tacoma West Hylebos Pier Waterfront Improvement Project Bioretention Stormwater Treatment System Engineering Report and Supplements 1 & 2*
- *Port of Seattle Terminal 46 Engineering Report and Supplement*
- *Port of Tacoma Olympic Container Terminal Stormwater Infrastructure Improvements Engineering Report*
- *Port of Tacoma North Intermodal Yard Stormwater Infrastructure Improvements Engineering Report*
- *Port of Tacoma South Intermodal Yard Stormwater Infrastructure Improvements Engineering Report*
- *Northland Services Stormwater Multimedia Filtration and Best Management Practice Improvements Engineering Report and Supplement.*

Table C-1 in Appendix C provides a comprehensive listing of stormwater treatment technologies identified in the listed resources. These are discussed in the following sections.

4.3 Evaluation of Stormwater Treatment Approaches

The following subsections describe the methodology applied to categorize stormwater treatment approaches listed in the tables in Appendix C and discussed in the previous section.

4.3.1 Physical and Operational Feasibility

The candidate treatment approaches listed in Table C-1 in Appendix C were initially screened for potential application at Washington State marine terminals based on a list of feasibility criteria. These criteria reflect the unique logistical issues for treating stormwater at marine terminals given their characteristic space limitations, flat site topography, high groundwater table, frequent presence of historical contamination, and effectiveness in treating ISGP pollutants of concern to meet benchmark levels. Based on these considerations, the following feasibility criteria were used to organize treatment approaches listed in the Appendix C tables for consideration at Washington State marine terminals:

- Systems with minimal aboveground footprints are advantageous due the space limitations in marine terminals [larger aboveground systems from the SWMMWW (e.g., constructed wetlands and wet ponds) were deprioritized based on this criterion].

- Systems reliant on infiltration for treatment were deprioritized due to typically high water tables and historical soil and/or groundwater contamination present at many marine terminals (treatment technologies, such as infiltration trenches, porous pavements, bioretention systems without underdrains, and proprietary systems that provide storage for underground infiltration). The use of infiltration or dispersion approaches to manage stormwater is encouraged though opportunities for application of these approaches are likely limited at many marine terminals.

- Systems that address ISGP pollutants of concern are considered the focus. Those systems with a focus on removing only gross litter and debris without addressing pollutants of concern were deprioritized.

- Systems designed for permanent installation are advantageous; those systems with a construction site or temporary installation focus were not considered in depth (e.g., basic catch basin filter designs are not listed).

The feasibility of specific treatment for use in marine terminals was evaluated by comparing the physical and operational characteristics of candidate treatment approaches in Appendix C to these criteria. Stormwater treatment approaches that were considered less feasible based on these criteria were listed towards the bottom of Table C-1.

4.3.2 Data Availability and Review

In general, Permittees should consider the quantity and quality of available performance data to determine whether a stormwater treatment technology will provide sufficient pollutant removal for meeting applicable benchmarks. Performance data for stormwater treatment systems in this Manual have been obtained from the Herrera report and PULD, CULD, and GULD documents posted to Ecology's Emerging Technologies website. Independent unpublished bench and pilot scale data have not been collected or considered. In all cases, the quantity and validity of vendor-supplied performance data have not been independently verified. This would include treatment performance data for technologies that have received a PULD or CULD certification through the TAPE program for basic (TSS), enhanced (dissolved metals), and oil treatment. Treatment performance data for technologies achieving a GULD certification have typically been

collected by a third party other than the vendor and have gone through an independent review by a board of external reviewers that supports the TAPE program.

Treatment technologies that have received a GULD from Ecology are presented in Table C-2 in Appendix C. In general, Permittees should have more confidence in the performance data for these treatment technologies due to the considerations discussed above. Furthermore, the performance information for each treatment technology in Table C-2 simply reflects the minimum required pollutant reduction effectiveness for obtaining a GULD through the TAPE program. For example, treatment technologies that have received a GULD for basic treatment must reduce TSS by at least 80 percent. Similarly, treatment technologies that have received a GULD for enhanced treatment must reduce dissolved zinc and copper by at least 60 and 30 percent, respectively. It must be noted, however, that Ecology's TAPE approval process requires BMP testing data exhibiting influent pollutant levels that may be below levels common in industrial stormwater discharges.

Select treatment technologies and their potential treatment effectiveness are presented in Tables C-3, C-4, and C-5 in Appendix C. These tables have been segregated and formatted to list treatment technologies on a pollutant-specific basis as follows, C-3 (total zinc), C-4 (total copper), C-5 (TSS). In most cases, performance data from these systems have been obtained from GULD, CULD, and PULD designation documents obtained from Ecology's Emerging Technologies website or the Literature Review of Existing Treatment Technologies for Industrial Stormwater (Herrera 2011) that is described above. Performance is characterized using a range or a single value to represent performance based on the data available in the referenced resources. Depending on influent pollutant concentrations, the listed technologies may not be adequate to treat runoff to below benchmark levels. Performance data for the treatment technologies in Tables C-1, C-3, C-4, and C-5 are all vendor supplied and have not been independently verified. Permittees are recommended to pilot test candidate treatment systems that are selected from this list to verify they will provide sufficient pollutant removal for meeting applicable ISGP pollutant benchmarks.

It should be noted that the performance of any treatment approach that is installed in response to a Level 3 Corrective Action will ultimately be verified through monitoring that is required under the ISGP. Furthermore, the compliance pathway identified in Section 2.0 of this manual identifies specific provisions for either upgrading treatment facilities or requesting a waiver from additional treatment if another Level 3 Corrective Action is triggered if ongoing monitoring indicates that it is required.

4.3.3 Pollutant Reduction Effectiveness

Considering available treatment performance data for the stormwater treatment approaches that were considered to be feasible at marine terminals, pollutant reduction effectiveness for each approach was listed in Table C-1 for the parameters below based on the data readily available for each in the reviewed resources. If no performance data were readily available for a given parameter, no pollutant reduction percentage is listed in the tables included in Appendix C:

- Total suspended solids (TSS)
- Total petroleum hydrocarbon (TPH)
- Oil and grease

- Total and dissolved copper
- Total and dissolved zinc.

Data for pollutant reduction effectiveness for turbidity and COD were unavailable for the majority of the stormwater treatment approaches included in Appendix C, and therefore, turbidity and COD reduction capability has not been included.

Table C-1 is a master list of all stormwater treatment technologies identified in the reviewed resources. Table C-2 presents treatment technologies from this master list that have received a PULD, CULD, or GULD from Ecology. Tables C-3, C-4, and C-5 in Appendix C were generated from the data included in the master Table C-1. These tables have been segregated and formatted to list treatment technologies on a pollutant-specific basis as follows: Table C-3 (total zinc), Table C-4 (total copper), Table C-5 (TSS). Treatment technologies are sorted in the tables in descending order based on the listed pollutant removal capability for the individual parameter considered in each table.

Tables C-3, C-4, and C-5 in Appendix C have also been color-coded to correspond with the performance ranking given to each stormwater treatment technology as set forth in Table 2 below. Table 2 shows the potential pollutant percent reduction for each parameter along with a corresponding maximum influent concentration that would require to be reduced in order to meet the ISGP benchmark. As described above, data for pollutant reduction effectiveness for turbidity and COD were unavailable for the majority of the stormwater treatment approaches included in Appendix C and therefore, turbidity and COD reduction capability has not been listed. Permittees will use Table 2 in conjunction with Tables C-2, C-3, C-4, and C-5 to select treatment methods under the AKART treatment selection methodology discussed in the following section.

Table 2: Treatment System Performance Categories for Selected ISGP Parameters

		Treatment System Performance		
ISGP Parameter	**ISGP Benchmark (where applicable)**	**Low (Bronze)[(a)]**	**Medium (Silver)[(b)]**	**High (Gold)[(c)]**
		Maximum Influent Concentration	Maximum Influent Concentration	Maximum Influent Concentration
Total Suspended Solids (TSS)	100 mg/L	<140 mg/L	<200	<500
Total Zinc	117 µg/L	<170 µg/L	<250 µg/L	<400 µg/
Total Copper	14 µg/L	<20 µg/L	<30 µg/L	<50 µg/L

Notes:

(a) Assumes approximate 30 percent reduction necessary to achieve benchmark level.
(b) Assumes approximate 50 percent reduction necessary to achieve benchmark level.
(c) Assumes reduction (percent) based on TAPE protocol goals for TSS (80) and metals (70) estimated based on technical achievability.

mg/L = milligram per liter
NTU = Nephelometric turbidity unit
µg/L = gram per liter

Section 5: AKART Stormwater Treatment Selection Methodology

Application of appropriate operational and structural source control BMPs is based on consideration of specific industrial activities performed in particular areas with the focus being on limiting introduction of pollutants to runoff in the first place through prevention of material exposure and pollutant contact. Once pollutants are present in runoff, a different approach needs to be applied to select appropriate and effective methods of stormwater treatment with the goal of reducing pollutant concentrations below ISGP benchmark levels.

The discussion included herein is intended to guide Permittees at the Level 3 Corrective Action stage with selection of appropriate stormwater treatment approaches that represent AKART based on the concentration of pollutants measured at their specific facility. The stormwater treatment approaches identified through the process defined herein are assumed to be included in Permittee's engineering reports submitted to Ecology to address ISGP Level 3 Corrective Action requirements. The methodology below is intended to also aid Ecology's engineering report reviewers to document that an appropriate Level 3 analysis was performed and to verify that the treatment approach selected meets State of Washington AKART standards.

It is critical to note that the stormwater treatment selection methodology defined herein is not mandatory and Permittees are free to investigate and implement whatever method of stormwater treatment meets the requirements of the ISGP and applicable law. The guidance provided herein is intended to aid Permittees in the stormwater treatment selection process and Ecology and the public with review of Permittee-proposed stormwater treatment approaches.

This document is intended as guidance only and does not modify or otherwise change the requirements in the ISGP. If there is any discrepancy between this guidance and the ISGP, the ISGP requirements supersede this guidance.

5.1 Concentration Based Evaluation

This section describes the methodology recommended for Permittees to implement in their selection of Level 3 treatment approaches at their facilities focusing on facility-specific stormwater quality utilizing the tools described in the previous section and the tables included in Appendix C.

1. Permittees will compile currently available stormwater quality data for their facility. For many, these data will be limited to laboratory analytical results from ISGP sampling. Collection of additional stormwater quality data is encouraged.

2. For each ISGP parameter of concern, Permittees then identify the median value (middle value in a sorted group of numbers) of sampling results for the period of time representative of current site conditions and implementation of BMPs.

3. Permittees then compare the median value for the ISGP parameter(s) of concern to the maximum influent concentrations listed in Table 2 in the previous section to assess whether the pollutant concentration in their discharges are categorized in the low, medium, or high range. Permittee, with measured median influent concentrations exceeding the high range identified in Table 2, should contact Ecology for facility-specific consideration.

4. Based on the influent concentration identified for the ISGP parameter(s) of concern in facility discharges, one or more treatment technologies will be selected from the Treatment Technologies BMP Lists included in Tables C-3, C-4, and/or C-5 in Appendix C with the listed pollutant reduction capability to achieve ISGP benchmark levels in future facility discharges. This may be an iterative process for Permittees with multiple parameters triggering Level 3 Corrective Actions. It is recommended that Permittees begin the stormwater treatment selection process with consideration of the parameter exceeding the ISGP benchmark to the greatest degree.

5. Permittees then perform a qualitative and quantitative evaluation discussed in the following section to establish whether the identified treatment technologies included in the Appendix C tables are appropriate and reasonable to implement at their facility. This evaluation and the final selection of the preferred stormwater treatment approaches are assumed to include consideration of the feasibility criteria and qualitative and quantitative considerations discussed in Sections 4 and 5 and the data provided in Appendix C.

6. If Permittees determine, based on their qualitative and quantitative evaluation that the stormwater treatment approach identified through the concentration-based evaluation ***is appropriate and reasonable*** to implement at their facility, they will prepare an engineering report for submittal to Ecology for review and approval documenting their stormwater treatment selection methodology.

7. If a Permittees determines, based on their qualitative and quantitative evaluation that the stormwater treatment approach identified through the concentration-based evaluation ***is not appropriate and reasonable*** to implement at their facility, they will conduct a facility-specific evaluation described in Section 6, intended to define the appropriate stormwater treatment approach for their facility. Their selected approach and justification will be documented in an engineering report for submittal to Ecology for review and approval.

Permittees that implement the stormwater treatment approach defined in engineering reports approved by Ecology either through the concentration-based methodology or through the facility-specific methodology will be considered to have applied AKART, satisfying their Level 3 Corrective Action responsibilities. The performance of installed treatment approaches would continue to be verified through the monitoring that is required in the ISGP.

5.2 Qualitative and Quantitative Evaluation

This section provides guidance to Permittees for qualitatively and quantitatively evaluating whether the stormwater treatment approaches identified during the concentration based evaluation process are considered to be appropriate to implement at their facility. Qualitative

criteria are considered to be those decisions that address strategy or operationally based influences. Quantitative criteria are generally considered to involve the capital and ongoing O&M costs, life cycle costs, and net present value (NPV) considerations associated with a specific stormwater treatment alternative. Qualitative and quantitative evaluations are often not mutually exclusive. For example, siting of stormwater treatment systems above grade saves the cost of excavation but may encumber valuable operational space. The criteria listed herein should not be considered to be all inclusive for the decision-making process, rather a recommended baseline.

5.2.1 Capacity to Achieve Current Benchmarks

The capability of treatment alternatives to reduce the ISGP pollutants of concern is a critical criterion to consider. Some metals, including zinc, are often present at elevated levels in the dissolved form in industrial runoff, so technologies that include a mechanism to reduce dissolved constituents would be considered favorable. In many cases, reducing all ISGP benchmark parameters may require a multi-stage treatment train. Permittees are encouraged to thoroughly characterize stormwater from their facility and carefully consider individual treatment technologies or combinations of approaches for adequacy based on their site-specific discharges. In many cases, pilot testing of candidate treatment approaches identified through the concentration-based selection process will be appropriate.

5.2.2 Adaptability

The adaptability of stormwater treatment systems is a qualitative consideration, intended to estimate the perceived flexibility of each treatment system to address varied potential pollutants and varying stormwater pollutant concentrations. This is especially critical for the marine terminal industry where commodities with variable characteristics may be handled at any time and which commodities are handled is often controlled by market conditions and regional competition.

5.2.3 Conveyance Alternatives and Treatment System Siting

The siting of stormwater treatment facilities is a significant consideration at most marine terminals due to potential impacts to facility operations and overall project costs. At first glance, from a terminal operations perspective, siting stormwater treatment facilities outside of primary operational areas would seem an attractive approach. However, this approach can be costly due to the general necessity for conveyance modifications to achieve this goal. Similarly, underground stormwater treatment approaches are often attractive from an operational space perspective but O&M of these systems may be difficult, requiring confined space entry for maintenance personnel. Another consideration is whether gravity-based systems can be accommodated at the facility given existing drainage system physical characteristics or if pumping of stormwater will be required.

5.2.4 Encumbered Operational Areas

All stormwater treatment alternatives will require space for runoff treatment to varying degrees. Above ground footprint areas generally need to be limited to areas outside of drive aisles due to the need to maintain required terminal circulation. Encumbered leased space for MTOs adds additional strain and cost to terminal operations and impacts the capacity and efficiency

terminals to handle cargo, especially near critical waterfront wharf areas. Consequently, preservation of space for commercial purposes is of key importance. Consideration of maintaining terminal operations is critical both during construction and once the treatment systems are in operation.

In general, stormwater treatment alternatives estimated to limit encumbered surface area would be preferred over those requiring more land. However, the significant differences in construction costs and footprint impacts of construction activities also need to be considered.

5.2.5 Capital Cost Considerations

Permittees faced with implementation of stormwater treatment often focus on comparing costs between different types of manufactured and non-proprietary treatment approaches. Though a valid criterion to consider, when it comes to the overall cost of implementing stormwater treatment at marine terminals, conveyance retrofit costs have generally been found to far exceed the treatment system cost differential. Similarly, it is commonly believed that economies of scale will make one large stormwater treatment system more cost effective than several smaller systems. Often this is not the case when the cost of conveying stormwater to centralized facilities is considered. Finally, review of the alternative analyses included in the engineering reports discussed in Section 4 indicates that the cost of treatment can more than double when stormwater pumping systems are required.

5.2.6 Operation and Maintenance and Life Cycle Costs

Perceived O&M costs are often a key decision-making concern when Permittees are deciding between implementation of different stormwater treatment approaches. Permittees are advised to exercise caution when basing long-term decisions on advertised O&M cost estimates. The real costs for operation and maintenance of a stormwater treatment system are largely correlated to pollutant loading, which depends on many factors including, but not limited to, the type and volume of commodities handled, the predominant equipment types used at the terminal, on and off highway vehicle traffic, facility location, degree of BMP implementation, etc. Also accurate estimation of O&M costs is critical when considering the overall life cycle costs for specific stormwater treatment alternatives as errors can be compounded over the life cycle period being considered.

Permittees are encouraged to ask stormwater treatment equipment vendors for detailed lists of cost factors when requesting O&M cost estimates, and be sure to ask for references where similar systems have been installed at similar facilities. Call the references and visit their facilities.

Section 6: Facility-Specific Evaluations

This section provides methodologies for Permittees to consider if the treatment approaches described under the concentration-based evaluation process are considered to be unreasonable or inappropriate at their facility based on their quantitative and qualitative evaluation described in Section 5.

As a reminder, Permittees always have the option to propose alternate stormwater treatment selection methodologies to the concentration-based and facility-specific approaches described in this Manual in engineering reports addressing their Level 3 Corrective Action responsibilities. However, Permittees should expect to justify their approach and applying processes described in this Manual to expedite Ecology's engineering report review and approval process.

6.1 General Facility-Specific Considerations

It is assumed that the Permittees proposing to apply the facility-specific evaluation approach discussed in this section will provide a discussion of the quantitative and qualitative criteria specific to their facility discussed in Section 5 of this Manual. Additional information including, but not limited to, the items listed below may be included in Permittee engineering reports to enhance Ecology's understanding of the Permittee's proposed Level 3 stormwater treatment approach:

1. Describe the overall stormwater treatment approach proposed to be implemented at the facility to address ISGP Level 3 corrective action responsibilities

2. Summarize facility stormwater characterization data

3. Describe Permittees existing and planned implementation of operational and structural source control BMPs at the facility and how they integrate with the Permittees proposed stormwater treatment approach (see Section 3). For example, explain how hydrocarbons and sediment will be controlled at the source to minimize the fouling of filtration, reduce incidence of bypass, etc.

4. Describe the feasibility, performance, and other applicable qualitative and quantitative criteria considerations for candidate stormwater treatment approaches the Permittee has considered for implementation at the facility and (See Sections 4 and 5)

5. Describe the reasonableness evaluation process applied in selection of the final stormwater treatment approach(es) proposed in the Permittees engineering report (methodologies included in this section).

6.2 Cost Benefit Evaluation

Permittees may use a cost-benefit/knee of the curve analysis to establish that the stormwater treatment approach they propose is the most appropriate and reasonable, given their specific facility characteristics. A knee of the curve evaluation can estimate the economic reasonableness of a specific stormwater treatment approach considering both the overall cost of a treatment alternative (including costs for stormwater treatment, conveyance revisions, etc.)

and the environmental or water quality benefit expected to be achieved. Ongoing O&M costs and overall life-cycle costs are also a significant consideration though much more difficult to estimate given facility-specific factors (e.g., gravel versus paved yards, frequency and intensity of operational and source control BMP implementation, etc.). For these reasons, ongoing O&M costs and overall life-cycle costs are not considered or discussed in the procedures described below but are anticipated to be included in a Permittee's discussion of qualitative and quantitative criteria in their engineering report.

The knee of the curve evaluation is analogous to the "disproportionate cost analysis" approach applied in the State of Washington as part of evaluating environmental cleanup projects conducted under the Model Toxic Control Act (MTCA). The disproportionate cost analysis process, "involves comparing the costs and benefits of alternatives and selecting the alternative whose incremental costs are not disproportionate to the incremental benefits." As previously mentioned, it is assumed that Permittees wishing to apply the disproportionate cost analysis procedure through a knee of the curve evaluation would document their approach in their facility-specific engineering reports required under Chapter 173-240 WAC to be stamped by a professional engineer.

6.2.1 Cost-Benefit (Knee of the Curve) Evaluation Procedure

This subsection describes a methodology for evaluating the reasonableness of Level 3 stormwater treatment approaches based on a knee of the curve evaluation procedure.

1. Permittees prepare an engineering cost estimate for implementing the stormwater treatment approach recommended at their facility using line item costs for construction categories listed in Marine Terminal Stormwater Treatment Cost Comparison Table E-1 included in Appendix E.
2. Permittees would also prepare and include engineering cost estimates in Table E-1 for alternative stormwater treatment approaches that the Permittee considered at their facility for comparison to their recommended approach. One or more of the alternate stormwater treatment approaches provided for comparison would be expected to be selected from the concentration-based tables included in Appendix C that meet the performance estimated to be required for discharges from the facility to meet the ISGP benchmark for the pollutant(s) of concern at the facility. When documenting these costs, one or more of the stormwater treatment technologies evaluated should carry a GULD designation for the ISGP pollutant(s) of concern if they are feasible at the site.
3. As presented in the example Table E-1 cost comparison, the Permittee would calculate the total estimated construction cost per gallon per minute (gpm) of stormwater treatment capacity necessary to meet the ISGP water quality flow rate standard for each stormwater treatment approach considered in the cost-benefit evaluation. The methodology used to calculate the water quality flow rate required for stormwater treatment is defined in the SWMMWW, taking into account the facility location, the area specified for stormwater treatment, how flow is routed through the proposed stormwater treatment BMP, and other factors specific to the particular facility and treatment system conceptual design.

Calculating the construction cost per gpm of stormwater treatment capacity for multiple alternatives is intended to provide the Permittee with the ability to document their comparison of alternatives on a normalized cost per unit of volume basis for Ecology consideration and comparison to other similar facilities during the engineering report review and approval process. This cost per unit of volume consideration is an important tool to compare similar treatment approaches in different regions with varied rainfall characteristics.

4. The Permittee would then plot the construction cost per gpm of stormwater treatment capacity required versus the estimated pollutant reduction percentage appropriate for each approach (or provided in the Appendix C tables for listed technologies as appropriate) to create a cost-performance curve.
5. The Permittee would then select the technology that is to the left of the inflection point (before the knee of the curve, if one exists) or select the stormwater treatment technology or approach represented by the median cost/gpm value calculated for the stormwater treatment approaches considered in Table E-1. The Permittee would document the process used to complete the cost-benefit evaluation supporting selection of the stormwater treatment approach they propose to be reasonable at their facility in their engineering report. An instructive example cost benefit evaluation, applying the methodology discussed above, is provided in the following section.

6.2.2 Example Cost-Benefit Evaluation

An example cost-benefit evaluation is provided in this subsection based on the stormwater treatment selection process performed at a large Northwest marine terminal. The example evaluation performed for selection of stormwater treatment at the facility is considered to be instructive as it follows the cost-benefit evaluation procedure listed above.

Cost Table E-2 includes a listing of six stormwater treatment alternatives considered at the example marine terminal, as well as engineer's cost estimates for the selected treatment alternative and the estimated conceptual costs for the five alternatives screened out during the qualitative and quantitative evaluation process. A companion chart depicting a cost-benefit curve comparing the estimated constructed cost per gpm of stormwater treatment capacity required to meet the SWMMWW water quality treatment requirements versus the zinc reduction percentage estimated for each alternative (or derived from the Appendix C tables) for each of the different stormwater treatment approaches considered is also included.

In this example, the constructed costs for screened stormwater treatment approaches are based on a conceptual level evaluation and the costs listed for the selected alternative are based on the engineer's estimate prepared prior to the project construction bid. The percentage reduction for zinc listed for each stormwater treatment alternative considered in the chart and Table E-2 were referenced from Table C-3 (Treatment Technology Listing – Total Zinc) in Appendix C. The specific treatment technologies and vendor names associated with the stormwater treatment alternatives considered have not been included.

6.3 Atypical Facility Evaluation

The concentration-based stormwater treatment selection methodology described in Section 5 of this Manual identifies treatment approaches that are generally considered to be reasonable for implementation at many marine terminals. Similar stormwater treatment approaches may not be considered reasonable at some seemingly similar facilities, however, due to facility-specific characteristics that could make implementation of the same type of stormwater treatment approach much more expensive. Some facility characteristics that could make one marine terminal "atypical" as compared to another and significantly impact the cost of similar stormwater treatment approaches could include:

- Several small areas draining to numerous outfalls versus larger drainage areas and fewer discharge locations.
- Unique stormwater conveyance or outfall characteristics (e.g., low outfall elevations preventing gravity based treatment approaches).
- Aged conveyance systems in poor condition requiring expensive repairs to prevent groundwater inflow versus newer facilities built to current design standards.
- Contaminated soils, high groundwater table, or other geotechnical or hydrogeologic conditions requiring expensive soil removal, shoring, dewatering, etc.
- The presence of vast unpaved areas versus completely paved facilities.
- Significant variations in traffic types or volumes of commodities handled.
- Discharge to a 303(d) listed water body or other site-specific discharge requirements.
- Unique facility management or operator characteristics (e.g., multiple tenants in shared facilities).

Permittees occupying atypical facilities may benefit from a facility-specific stormwater treatment selection approach that limits the documentation that may be required to demonstrate that alternatives to the concentration-based approach are warranted. Under this scenario, Permittees at the Level 3 Corrective Action stage may wish to consider comparison of their individual facility characteristics to others in their industry that have already implemented stormwater treatment.

To aid in these comparisons, select physical characteristics for some Northwest marine terminals are included in Table E-3 for the marine terminals listed below and described in engineering reports reviewed in preparation of this Manual.

- Port of Tacoma Olympic Container Terminal (OCT)
- Port of Tacoma North Intermodal (NIM) Yard
- Port of Tacoma South Intermodal (SIM) Yard

- Port of Tacoma West Hylebos Pier Logyard
- Northland Services Port of Seattle Barge Facility
- Port of Olympia Marine Terminal.

All of the listed marine terminals are located at Washington public ports and have reached the Level 3 Corrective Action stage for ISGP pollutants of concern requiring implementation of stormwater treatment. Each facility has submitted an engineering report prepared in accordance with Chapter 173-240 WAC and received Ecology approval and each of these facilities has been publically bid or will be bid in 2014.

It should be noted that the stormwater treatment solutions provided in Tables E-2 and E-3 in Appendix E represent treatment approaches installed at facility outfall locations, which may not be appropriate for many marine terminals required to implement Level 3 Corrective Actions under the ISGP. Similarly, near source stormwater treatment approaches that are generally preferred, may also not be appropriate for all Permittees. The evaluation procedures listed in this section should be considered to be guidance, and Permittees are reminded that they are encouraged under the ISGP and the SWMMWW to focus their efforts on controlling stormwater pollution through application of operational and structural source control BMPs. Furthermore, alternate stormwater management solutions to those provided in this Manual and other approved guidance documents may be implemented where they are documented to be appropriate and reasonable and testing has shown they are effective. The example stormwater treatment approaches listed in Appendix E should not be viewed as typical and are not purported to characterize what should be expected at other Washington State marine terminals.

The examples provided in Tables E-2 and E-3 are included for Permittee reference for stormwater treatment approaches at facilities with similar operational characteristics to estimate the degree of similarity or difference between facilities. For example, the selected stormwater treatment approach listed for the example marine terminal in Table E-2 includes below grade proprietary media filtration systems. The same proprietary media filtration system may be attractive but much more expensive at a very similarly operated marine terminal with different outfall characteristics or with several more outfalls to address. In such a case, the Permittee could make a case to Ecology that their facility-specific characteristics warrant a different stormwater treatment approach. This rationale could be provided as a portion of the facility-specific evaluation supporting selection of an alternate stormwater treatment approach in the engineering report submitted to Ecology for consideration.

6.4 Facility-Specific Economic Evaluation

It is also important to consider whether implementation of specific stormwater treatment approaches will cause undue economic hardship to the facility operator. EPA has developed guidance to establish whether a technology is reasonable at facilities required to implement the BAT economically achievable, termed the BAT Economic Achievability Test detailed in the PWM. The BAT Economic Achievability Test may or may not represent a practical solution in establishing what stormwater treatment approach will provide the most environmental benefit if a facility makes little or no profit from their operations. The economic evaluation discussed herein is intended to focus on preventing facility closure in accordance with state and federal guidelines rather than just limiting a loss in facility profits.

Permittees seeking alternate stormwater management approaches to those defined in this Manual or other appropriate stormwater guidance documents due to facility-specific economic considerations are encouraged to engage Ecology regarding use of the BAT Economic Achievability Test or other appropriate tools to demonstrate that the stormwater management approaches that they propose meet Washington State AKART standards.

It is not uncommon for marine terminals located at public port facilities to operate at the breakeven point. One example may be a waterfront log yard that makes very little profit beyond the expense required to maintain its facilities and equipment yet supports numerous family wage jobs for truckers and others that support the industry. It is assumed that Permittees in an economic situation, which may prevent them from implementing a stormwater treatment approach meeting ISGP Level 3 Corrective Action requirements, will provide facility-specific profit and loss data and a discussion of what they consider to be the maximum reasonable treatment at their facility in their engineering report submitted for Ecology review.

Section 7: Post-Treatment Corrective Actions

This section discusses corrective actions for facilities that have already implemented Ecology-approved Level 3 treatment, as defined through the AKART compliance pathway described in Section 2 of this Manual and therefore, it is presumed that the Permittee has already met Washington State AKART standards. The process for evaluating and implementing corrective actions following implementation of AKART is the same as prior to implementation of stormwater treatment; however, it is understood that stormwater treatment system performance should be evaluated on an ongoing and expedient basis to optimize stormwater treatment system performance to limit benchmark exceedances.

Permittees may engage Ecology to determine whether the treatment facility installed under the previous Level 3 can be upgraded to more effectively treat stormwater. In some cases, the existing treatment system may be augmented by a pre-treatment or polishing step, i.e., expanded the "treatment train." Recommended actions for Permittees that have already implemented a Level 3 Corrective Action are provided below.

7.1 Level 1 and 2 Corrective Actions

Once a Level 3 Corrective Action has been implemented, Permittees will continue to monitor stormwater discharges and compare results to ISGP benchmarks. Each time a benchmark is exceeded, Permittees must implement a Level 1 Corrective Action. As with all Level 1 activities, Permittees are required to review implementation of BMPs to maximize their effectiveness. Continued review of sources and implementation of additional source controls are required in the ISGP and could include increased frequency of operational source control BMP implementation, as appropriate. As is appropriate for all Level 2 Corrective Actions, if triggered, Permittees are required to further evaluate additional structural source controls to reduce pollutants in stormwater.

Permittees are encouraged to evaluate their existing treatment system to make sure it is operating according to design. Treatment systems typically require minor modifications, particularly during startup, to operate effectively. This may require continued monitoring and evaluation of influent to the treatment system, as well as modifying treatment system components to make sure they are working as designed. It is often difficult to estimate the longevity of treatment media and the maintenance that may be required prior to installation. Influent and effluent monitoring is recommended until treatment conditions and maintenance schedules are established.

7.2 Level 3 Upgrades

The AKART compliance pathway presented in this Manual anticipates that treatment systems installed by Permittees in accordance with engineering reports approved by Ecology constitute AKART with regard to stormwater treatment for a particular facility. If a facility triggers a subsequent Level 3 Corrective Action following implementation of stormwater treatment, meeting Washington State AKART standards, Permittees will need to evaluate whether additional treatment BMPs or treatment upgrades can be implemented with the goal of achieving benchmarks in future discharges. It would be appropriate at this stage for Permittees

to evaluate whether the treatment system installed under their previous Level 3 Corrective Action can be optimized or upgraded to improve treatment performance. The following treatment system operational considerations may be evaluated by Permittees in an effort to maximize the effectiveness of their current treatment system. Augmentation or modification of the existing treatment system applying a combination of the concepts described below may be appropriate to include in an engineering report to address post-treatment Level 3 Corrective Actions, but are recommended to be considered by Permittees as early as the Level 1 Corrective Action stage.

- Consider potential flow equalization options, including investigating additional storage capacity using existing infrastructure.

- Testing and implementation of alternate media used to treat pollutants. Implementation of alternate media is considered to represent a change in media type, configuration, particle size, etc., supported by documentation of the alternate media evaluation and selection process in a facility's Engineering Report, rather than regular media replacement, which is expected under normal stormwater treatment system maintenance.

- Potential additional upstream near source treatment (or pre-treatment) of stormwater. For example, installing roof runoff media filtration to reduce dissolved zinc concentrations from roof runoff before it is passed through the existing Level 3 treatment system.

- Potential post-treatment polishing, which may or may not require structural upgrades.

The results of the post-AKART Level 3 Corrective Action would be presented in an engineering report to be submitted to Ecology for review and approval, describing enhancements or existing stormwater treatment system upgrades to be implemented.

7.3 Modifications of Permit Coverage

This section describes the anticipated process for obtaining a waiver from further treatment through a Modification of Permit Coverage.

The ISGP states that Ecology may waive the requirement for Treatment BMPs if installation is not feasible or not necessary to prevent discharges that may cause or contribute to violation of a water quality standard. To request a waiver, a Permittee is required to submit a Modification of Permit Coverage form to Ecology, along with a detailed technical basis to explain why additional treatment is not feasible or unnecessary to prevent discharges that may cause or contribute to violation of a water quality standard. The Modification of Permit Coverage process requires the Permittee to provide public notice and opportunity for public comment at least once a week for 2 consecutive weeks with 7 days between publications in a single newspaper of general circulation in the county in which the facility is located. Ecology will consider any public comments submitted on the proposed Modification of Permit Coverage.

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Appendix A

Applicable (Mandatory) Operational and Structural Source Control BMPs

Appendix A: Applicable (Mandatory) Operational and Structural Source Control BMPs

This Appendix presents a master list of best management practices (BMPs) that are considered to be applicable (mandatory) for implementation at each of the four categories of marine terminal facilities considered in this Manual. It includes the operational and structural source control BMPs listed in the Industrial Stormwater General Permit (ISGP), the Stormwater Management Manual for Western Washington (SWMMWW), and ISGP Implementation Manual for Log Yards, as appropriate at marine terminal facilities. The table categorizes individual BMPs based on land use and/or activity, with reference to where clarifying information can be found.

Not all applicable BMPs in the SWMMWW and other potentially applicable guidance documents have been included in Appendix A, as not all of the mandatory BMPs in the guidance documents are considered to be applicable at many marine terminals. It is the Permittee's responsibility to ensure that all applicable BMPs are included in the facility SWPPP and that ISGP conditions are satisfied.

Master Best Management Practice (BMP) List
Washington Public Ports Association (WPPA)
Washington State Ports Marine Terminal All Known, Available, and Reasonable Methods of Prevention, Control and Treatment (AKART) Study

Applicable (Mandatory) BMPs[a]	BMP Source			Log Yards	Container Yards	Break Bulk Yards	Bulk Yards
Pollution Prevention Team		SWMM Volume IV. Section 2.1[d]	Log Yard Manual Section 4[c]	X	X	X	X
Good Housekeeping	ISGP S3.B[c]	SWMM Volume IV. Section 2.1	Log Yard Manual Section 4	X	X	X	X
Preventive Maintenance	ISGP S3.B	SWMM Volume IV. Section 2.1	Log Yard Manual Section 4	X	X	X	X
Spill Prevention and Cleanup	ISGP S3.B	SWMM Volume IV. Section 2.1	Log Yard Manual Section 4	X	X	X	X
Employee Training	ISGP S3.B	SWMM Volume IV. Section 2.1	Log Yard Manual Section 4	X	X	X	X
Inspections and Recordkeeping	ISGP S3.B	SWMM Volume IV. Section 2.1	Log Yard Manual Section 4	X	X	X	X
Illicit Connections to Storm Drains	ISGP S3.B			X	X	X	X
Structural Source Control BMPS	ISGP S3.B			X	X	X	X
Treatment BMPs	ISGP S3.B			X	X	X	X
Stormwater Peak Runoff Rate and Volume Control BMPs	ISGP S3.B			X	X	X	X
Erosion and Sediment Control BMPs	ISGP S3.B		Log Yard Manual Section 4	X	X	X	X
S406 BMPs for Streets/Highways		SWMM Volume IV. Section 2.2		◊	◊	◊	◊
S407 BMPs for Dust Control at Disturbed Land Areas and Unpaved Roadways and Parking Lots		SWMM Volume IV. Section 2.2		◊	◊	◊	◊
S408 BMPs for Dust Control at Manufacturing Areas		SWMM Volume IV. Section 2.2		◊			◊
S409 BMPs for Fueling at Dedicated Stations		SWMM Volume IV. Section 2.2		◊	◊	◊	◊
S410 BMPs for Illicit Connections to Storm Drains		SWMM Volume IV. Section 2.2		X	X	X	X
S411 BMPs for Landscaping and Lawn/ Vegetation Management		SWMM Volume IV. Section 2.2		◊	◊	◊	◊
S412 BMPs for loading and unloading areas for liquid or solid material		SWMM Volume IV. Section 2.2	Log Yard Manual Section 5				◊
S413 BMPs for Log Sorting and Handling		SWMM Volume IV. Section 2.2		X		◊	◊
S414 BMPs for Maintenance and Repair of Vehicles and Equipment		SWMM Volume IV. Section 2.2		◊	◊	◊	◊
S415 BMPs for Maintenance of Public and Private Utility Corridors and Facilities		SWMM Volume IV. Section 2.2		◊	◊	◊	◊
S416 BMPs for Maintenance of Roadside Ditches		SWMM Volume IV. Section 2.2		◊	◊	◊	◊
S417 BMPs for Maintenance of Stormwater Drainage and Treatment Systems		SWMM Volume IV. Section 2.2		X	X	X	X
S418 Manufacturing Activities - Outside		SWMM Volume IV. Section 2.2					◊
S419 BMPs for Mobile Fueling of Vehicles and Heavy Equipment		SWMM Volume IV. Section 2.2	Log Yard Manual Section 5	◊	◊	◊	◊

Master Best Management Practice (BMP) List
Washington Public Ports Association (WPPA)
Washington State Ports Marine Terminal All Known, Available, and Reasonable Methods of Prevention, Control and Treatment (AKART) Study

Applicable (Mandatory) BMPs[(a)]	BMP Source			Log Yards	Container Yards	Break Bulk Yards	Bulk Yards
S420 BMPs for Painting/ Finishing/ Coating of Vehicles/Boats/ Buildings/ Equipment		SWMM Volume IV. Section 2.2		◊	◊	◊	◊
S421 BMPs for Parking and Storage of Vehicles and Equipment		SWMM Volume IV. Section 2.2		**x**	**x**	**x**	◊
S422 BMPs for Railroad Yards		SWMM Volume IV. Section 2.2		◊	◊	◊	◊
S424 BMPs for Roof / Building Drains at Manufacturing and Commercial Buildings		SWMM Volume IV. Section 2.2		◊	◊	◊	◊
S425 BMPs for Soil Erosion and Sediment Control at Industrial Sites		SWMM Volume IV. Section 2.2	Log Yard Manual Section 5	**x**	**x**	**x**	**x**
S426 BMPs for Spills of Oil and Hazardous Substances		SWMM Volume IV. Section 2.2		**x**	**x**	**x**	**x**
S427 BMPs for Storage of Liquid, Food Waste, or Dangerous Waste Containers		SWMM Volume IV. Section 2.2	Log Yard Manual Section 5	◊	◊	◊	◊
S428 BMPs for Storage of Liquids in Permanent Aboveground Tanks		SWMM Volume IV. Section 2.2	Log Yard Manual Section 5	◊	◊	◊	◊
S429 BMPs for Storage or Transfer (Outside) of Solid Raw Materials		SWMM Volume IV. Section 2.2		**x**		◊	**x**
S431 BMPs for Washing and Steam Cleaning Vehicles/ Equipment/ Building Structures		SWMM Volume IV. Section 2.2	Log Yard Manual Section 5	◊	◊	◊	◊
BMPs at High Activity Areas			Log Yard Manual Section 5	**x**			
BMPs at Wood Waste Debris and Bark Piles			Log Yard Manual Section 5	**x**			
BMPs at Storage and Handling Areas of Other Solid and Hazardous Wastes			Log Yard Manual Section 5	**x**			
BMPs for the Control of Stormwater Leachates and Soil Erosion from All Material Storage Pile Areas			Log Yard Manual Section 5	**x**			
BMPs at Storage and Handling Areas of Other Solid and Hazardous Wastes			Log Yard Manual Section 5	**x**			
BMPs for Liquid/Fuel Handling Areas			Log Yard Manual Section 5	**x**			
BMPs for Liquid Storage in Portable Containers			Log Yard Manual Section 5	**x**			
BMPS at Maintenance Shops			Log Yard Manual Section 5	**x**			
BMPs for Soil Contaminated with Oil/Grease and/or Toxics Such as Pesticides and Metals			Log Yard Manual Section 5	**x**			

Master Best Management Practice (BMP) List
Washington Public Ports Association (WPPA)
Washington State Ports Marine Terminal All Known, Available, and Reasonable Methods of Prevention, Control and Treatment (AKART) Study

Applicable (Mandatory) BMPs[(a)]	BMP Source			Log Yards	Container Yards	Break Bulk Yards	Bulk Yards
BMPs for Basic Summary Approach for Stormwater Collection and Conveyance			Log Yard Manual Section 5	x			
BMPs for Surface Protection of Logs with Sapstain Control and/or Fumigant Chemicals			Log Yard Manual Section 5	x			
Treatment BMPs for Log Yards			Log Yard Manual Section 6	x			
Engineering Practice for Treatment BMPs at Log Yards			Log Yard Manual Section 7	x			

Notes:

(a) Please note that each BMP listed may include additional and associated BMPs defined in the listed guidance documents
(b) BMPs selected from Stormwater Management Manual for Western Washington. Volume IV Source Control BMPs, Sections 2.1 and 2.2, August 2012
(c) BMPs selected from the Industrial Stormwater General Permit Implementation Manual for Log Yards, Sections 4, 5, 6, and 7
(d) BMPs selected from the Industrial Stormwater General Permit, Effective Date: January 1, 2010 and Modification Effective Date: July 1, 2012

x = Required

◊ = Conditionally required as applicable at a given facility

Appendix B

Level 1 and 2 Corrective Action Recommendations

Appendix B: Level 1 and 2 Corrective Action Recommendations

All Permittees are recommended to consider implementing appropriate best management practices (BMPs) from this Appendix at their facilities and incorporating additional BMP guidance (e.g., increase frequency of BMP implementation) into their facility SWPPP in accordance with Industrial Stormwater General Permit (ISGP) requirements. Although the nature of industrial activity and materials at marine terminals is similar, there are site-specific differences between facilities that will affect whether a particular corrective action is appropriate to implement at any particular facility. Some differences include variations in operational characteristics, the acreage at which specific land uses and activities are present, the overall acreage of the terminal, stormwater conveyance configurations, traffic volumes, and pavement types, etc. Implementing operational and structural source controls as close to the sources of pollution as possible is a basic tenet of efficient stormwater management. Focused BMP implementation can also help to reduce pollutant discharge concentrations, ISGP compliance costs, and the level of stormwater treatment that may be necessary in the future.

B.1.1 Increased Frequency of Operational Source Control BMP Implementation

One response to address Level 1 corrective action requirements is to augment mandatory BMPs, by increasing the frequency or intensity of which they are implemented. The following are suggestions for augmenting the frequency of mandatory source control BMPs to increase operational source control effectiveness with the goal of meeting the benchmarks.

- **Improve housekeeping, including more frequent inspections**. Good housekeeping is required in the ISGP. Improved housekeeping practices may include completing activities at a greater frequency than identified in the facility stormwater pollution prevention plan SWPPP. More frequent inspections of work areas and shops, as well as equipment, will aid in the early identification of drips and leaks. When inspections occur on a more frequent basis (i.e., weekly rather than monthly, depending on the frequency and use of the area being inspected), problem areas can be addressed more quickly.

- **Implement more intense and frequent sweeping**. Quarterly sweeping of paved surfaces is also required in the ISGP. More frequent sweeping (i.e., on a weekly or monthly basis, rather than quarterly) is generally an appropriate BMP for marine terminals. Regenerative air sweepers are the current standard considered to be the most effective in removing particulates, which represent a major source of turbidity and metals. It is important to make sure that the materials comprising the sweeper (i.e., metal bristles) do not contribute pollutants to stormwater. In addition, the speed at which the sweeper operates is paramount to sweeper effectiveness. As general guidance, it is recommended that sweepers not be operated at speeds above the manufacturer's recommendations. Sweepers also need to be cleaned and maintained on a regular basis. It is recommended that manual sweeping be considered in areas that are not accessible by sweeper or where sweepers are not as effective (i.e., waterfront log yards). Also, teaming a helper equipped with a backpack blower to blow debris from hard to reach areas into the sweeper truck's path can be an effective approach. The

appropriate schedule for increased sweeping, established based on specific facility operational and water quality considerations, must be clearly defined in the facilities SWPPP.

- **Inspect and maintain tanks, tarps, roofs, vaults, and oil/water separators more frequently**. Salt present in marine air, can degrade plastics and rubber. It is recommended that tarps and tanks (including seals and valves) be inspected and maintained frequently than may be recommended by the manufacturer or the Ecology's Stormwater Management Manual for Western Washington (SWMMWW) to maintain adequate cover and prevent leaks. Settling vaults and oil/water separators in heavy use areas also may warrant frequent inspection.

- **Conduct preventative maintenance and more frequent inspections of equipment and vehicles**. Monthly vehicle and equipment inspections are required in the ISGP. Performing preventative maintenance on equipment and vehicles on a more frequent basis can address potential problems more quickly. Also, workers are to be trained to report observed problems.

- **Clean or replace catch basin inserts more frequently**. Catch basins at marine terminals typically capture stormwater from large areas of pavement and catch basin inserts may need to be cleaned or replaced once per quarter or more frequently to maintain flow and to effectively trap pollutants.

- **Inspect, jet, and repair stormwater conveyance system on a routine basis**. Inspecting, jetting, and repairing catch basins, manholes, and storm drain lines on an as needed basis are required in the SWMMWW. When completed on a regular basis (as opposed to on an as needed basis), the jetting of the subsurface stormwater conveyance system can be an effective source control BMP by reducing the accumulation of sediment in the pipes, particularly in high source areas. These accumulated sediments have been shown to contribute to elevated turbidity and TSS in discharges at many facilities. Make sure that jetting wash water is collected and properly disposed. Filtration and recycling of jetting wash water can be an effective approach to limit the amount of water requiring disposal. Broken subsurface pipelines can lead to pipe bedding material entering the drainage system increasing sediment issues and potentially undermining the pavement above.

B.2 Other Operational Source Control BMPs to Consider

This subsection identifies other potentially appropriate operational source control BMPs to reduce pollutants in stormwater at marine terminals. These operational source control BMPs were developed based on recommendations from the Ports and MTOs based on their experience and operations.

- **Source reduction (alternative commodity handling)**. To the extent practical, Permittees are encouraged to consider handling commodities that do not contribute pollutants to stormwater. Prior to accepting commodities, Permittees are recommended to investigate what materials are used in the construction and finishing of the materials to be handled and evaluate potential impacts to stormwater.

- **Rotate product storage areas to the extent possible**. Periodically rotating where materials (i.e., containers, logs, break bulk, etc.) are stored can allow for periodic and thorough cleaning of these areas. Take advantage of opportunities when areas are cleared to access and clean storm drain components that may be covered on a normal basis.

- **Store source materials contributing pollutants under cover**. The storage of materials (equipment, raw and finished products, and maintenance items) under cover is an appropriate, common, and effective BMP to reduce stormwater contact with pollutants. Many materials thought to be inert can contribute dissolved metals and particulates to runoff.

- **Conduct facility operations under cover, where possible**. Activities, such as welding, grinding, and cutting can take place at numerous and disparate areas at marine terminals. These types of activities can release particulates (with metals) that can contribute pollutants to stormwater. To most effectively limit pollutant contact with stormwater, it is recommended that these activities be completed indoors or under cover to the extent practicable.

- **Localize fuel storage and fueling operations (limit mobile fueling)**. Fueling at many marine terminals occurs at a centralized location. However, mobile fueling is common to limit equipment downtime and, in some cases, is unavoidable depending on site operations. A designated fuel pad and/or fueling area may help some terminals eliminate mobile fueling operations entirely; other terminals may still have a need for mobile fueling, but the frequency and types of equipment subject to mobile fueling may be reduced. Consolidation of fueling activities limits areas of the facility potentially subject to dripping or leaking fuel and limits where fueling BMPs need to be implemented.

  Mobile fuel transfer operations offer an opportunity to seek creative covering solutions. Make sure that contracted fuel providers are trained in proper implementation of BMPs that are appropriate at the facility.

- **Seek alternative products for vehicles and equipment, if available**. Consider the use of alternate fuels, lubricants, and other vehicle components that use less copper, zinc, and oil. Brake pads containing lower concentrations of metals are becoming more available and several marine terminals have replaced traditional hydraulic oils with vegetable oil-based products. More and more of these products are coming to the market to address pollutant issues, and Permittees are encouraged to seek out and try alternative materials.

B.3 Structural Source Control BMPs to Consider for Level 2 Corrective Actions

Structural source controls that are applicable (mandatory) must already be implemented as part of the facilities SWPPP implementation. When a Level 2 Corrective Action is triggered, permittees must implement additional structural source control BMPs with the goal of meeting ISGP benchmarks. In some cases, Permittees should consider structural source control BMPs

that are recommended by Ecology in the SWMMWW to address ISGP Level 2 Corrective Action requirements.

The structural source control BMPs listed below were developed based on discussions with the Ports and MTOs based on their experience and operations:

- **Routinely inspect, repair, and seal pavement**. Paving of unpaved portions of yards may reduce solids loading to stormwater. Prompt repair or replacement of substantially cracked or otherwise damaged pavement is required in the SWMMWW. Cracked and alligatored pavement can increase the turbidity and metals in stormwater, as particulates trapped in asphalt cracks can be entrained in stormwater. Asphalt itself contains metals, and sediment and tire rubber accumulated in cracks is difficult to remove by sweeping. Often, pavement sealing can be effective in reducing these problems. For facility improvement or retrofits, permeable pavement in select areas may be appropriate although the potential for spills needs to be considered.

- **Surfacing alternatives**. Consider the use of recycled asphalt as an alternative to gravel to address dust control and to control turbidity in unpaved areas.

- **Coat or replace fencing, roofing, and other exposed material.** Coating existing infrastructure (galvanized roofs, fences, buildings, gutters, etc.), which may be leaching metals (zinc and/or copper), or considering alternatives to building materials that contain metals can reduce pollutant loading to stormwater. Just because a material has an existing paint or coating does not ensure that it is inert; many paints contain zinc oxide. Degraded or chalky coatings can contribute fine particulates that can have a high zinc content and degraded coatings often expose underlying metal that is often galvanized.

  Also note that many asphalt shingle products contain zinc and copper included by the manufacturer to control moss and algae growth. Facilities are encouraged to either substitute these building materials and operations equipment with products that do not contain (or have reduced concentrations) of zinc or copper or to coat the existing materials with low-zinc/copper or zinc/copper-free paint.

  It is recommended that the cost of replacement with zinc- or copper-free materials be evaluated when coating is being considered, as coating costs often can be comparable to replacement costs. It is also suggested that the evaluation consider the remaining useful life of the exposed material, as well as useful life of any coating that will be used because painted and coated surfaces may require ongoing maintenance, and recoating and repainting is often necessary.

- **Install/construct cover for equipment and storage areas**. Constructing new roofs and covers may be appropriate for equipment (such as tools or generators) or bulk materials (such as used or new tires) to minimize stormwater contact. Constructing new cover for major products handled at marine terminals, such as containers, logs, bulk, and break bulk may not be possible. Using sheds, garages, lean-tos, canopies, or tarps to provide cover is appropriate for many marine terminal facilities where equipment or bulk materials are routinely stored due to the sheer volume and the ongoing handling of these materials.

- **Install rumble strips and tire washes**. Rumble strips and tire wash facilities can remove accumulated mud and brake dust from the wheels and tires of vehicles and reduce the spread of these materials throughout marine terminals. Collected solids and wash water must be contained and properly disposed.

- **Discharge or conditional discharge (valve controlled) to sanitary sewer**. In general, most public wastewater treatment facilities do not accept stormwater, except in extreme circumstances and generally only after storage and metering during low flow periods. At some marine terminals, it may be feasible for drainage systems in high source areas to be equipped with a valve to conditionally drain to a sanitary sewer. In such cases, the facility must receive approval to discharge to the sanitary sewer from the local sewer authority prior to installation of a connection to the sanitary sewer. At some marine terminal facilities with onsite wash racks or equipment cleaning operations, valve-controlled discharge system is already permitted and in place.

- **Rerouting of drainage**. Grade or berm outdoor maintenance areas to limit migration of stormwater containing pollutants or to limit contact of clean stormwater with pollutant sources. Reducing or eliminating stormwater from offsite or non-ISGP coverage areas may reduce the extent and cost of BMP implementation, including potential treatment. Permittees are encouraged to evaluate their drainage systems and reduce or eliminate mixing through rerouting drainage flows to the extent practical.

Appendix C

Level 3 Treatment Technologies

Appendix C: Level 3 Treatment Technologies

This Appendix includes a listing of stormwater treatment approaches categorized based on their feasibility at marine terminals, applicability for treatment of the Industrial Stormwater General Permit (ISGP) constituents of concern, and estimated pollutant reduction effectiveness. The listing of proprietary technologies and non-proprietary stormwater treatment methods are provided from the Ecology's Stormwater Management Manual for Western Washington (SWMMWW), Ecology's Technology Assessment Protocol Ecology (TAPE), CTAPE, California Department of Transportation Best Management Practice (BMP) Technology Report, and Ecology's Stormwater Treatment Technology Literature Review. The technologies are listed based on the criteria included in Section 4 of this Manual and should not be characterized to be listed based on preference or other subjective criteria. The data compiled in the Tables included in Appendix C may not be comprehensive and fully up to date as the information was sourced from existing available resources. The stormwater treatment methods listed should also not be considered to include all available stormwater treatment approaches that exist. Two example stormwater treatment methods shown to have valuably utility at marine terminals, though not listed, not listed in the referenced resources include:

- Fabric Catch Basin Filters with Media Amendments. Catch basin fabric filters can be effective at reducing larger particulate pollutant loading and they may be appropriate for use at many areas in marine terminals due to low cost and ease of implementation. Many filter fabrics are available; the finer the mesh, the greater amount of particulates will be removed. Finer mesh fabrics will need to be cleaned and/or replaced more frequently as they become plugged with particulates leading to overflow of the insert, negating the BMPs effectiveness. Keeping the facility clean (through sweeping or other good housekeeping techniques) will reduce the required maintenance schedule. Several different types of media are commercially available that may enhance reduction of pollutants in facility runoff (i.e., biochar, crushed oyster shells, oil, absorbents, vendor-supplied media, etc.). Permittees are recommended to investigate and pilot test various types of media to augment the effectiveness of catch basin filters and to identify amendments appropriate for use at their individual facilities.

- Roof Downspout Treatment. Even coated or roofs that do not contain metals represent an ongoing source of pollutants due to atmospheric deposition. An effective method of addressing this ongoing source is disconnection of roof downspouts from subsurface drainage systems and installation of roof runoff treatment. Accumulated pollutants from atmospheric deposition can be abated through the application of inexpensive and effective treatment systems such as the GRATTIX non-proprietary roof runoff treatment system tested by the ports of Vancouver and Tacoma, Washington. Instructions on how to build your own low cost GRATTIX and other helpful information can be found at the Washington Stormwater Center's website: www.wastormwatercenter.org.

Permittees are encouraged to investigate all stormwater treatment technologies and approaches listed in Table C-1 that may be appropriate to reduce facility stormwater discharge pollutant parameters to below ISGP benchmark levels. Several non-proprietary approaches are included in Table C-1 that do not appear in Tables C-3 through C-5 as applicable pollutant reduction data for all of the stormwater treatment BMPs listed in Table C-1 were not readily

available. Permittees should focus on the qualitative and quantitative criteria discussed in Section 5 of this manual considering site feasibility, specific pollutants to be addressed, capital, and operations and management (O&M) cost considerations, as well as sustainability of approach when selecting appropriate stormwater treatment BMPs for implementation at their facilities.

Incorporation of Low Impact Development (LID), green infrastructure principals should be considered first, to maximize the overall environmental benefit and to limit adverse impacts resulting from Level 3 Corrective Actions. In many cases, the correct stormwater treatment strategy to address ISGP Level 3 Corrective Action requirements will include non-proprietary solutions. In the Water Quality Program Permit Writer's Manual (PWM), pollution prevention is defined as "source reduction; or protection of natural resources by conservation; or increased efficiency in the use of raw materials, energy, water or other resources" and is one of the stated priorities of Ecology's water quality program. During derivation of technology-based effluent limits for individual permits, the PWM requires consideration of "non-water quality environmental impacts (including energy requirements)." Non-water quality environmental impacts may include ongoing energy requirements to operate treatment systems; embodied energy in equipment and consumables; waste disposal issues for cartridges, filters, media, etc.; potential restoration of the natural hydrologic cycle and ecosystem function; aesthetic value; and additional ecological values, such as creation of wildlife habitat that may serve as migratory bird stopovers or support local populations.

TABLE C-1

TREATMENT TECHNOLOGY MASTER LIST

Manufacturer/Vendor	Treatment BMP[a]	BMP Source	Process Technology Type	Constituents Treated (% Reduced)[b][c]						
				TSS	TPH	Oil/ Grease	Total Copper	Dissolved Copper	Total Zinc	Dissolved Zinc
Americast	Filterra	Emerging Tech[d] Herrera[e] CalTrans B-3&8[f]	Bioretention/ Filtration	70% - 96%	93%	18%	82% - 84%	40%	56%	54%
Abtech Industries	Ultra-Urban Filter	Herrera	Drain Inlet Insert (Absorbent Boom/Fabric)	80%	90%	85%				
ADS Water Quality Unit	ADS Water Quality Unit	Herrera	OWS	80%		80%	74%	74%	74%	74%
AquaShield	AquaSwirl	Emerging Tech Herrera CalTrans B-63	Hydrodynamic Separation	80% - 91%						
AquaShield	Aqua-Guardian CB Insert	Herrera	Drain Inlet Insert (Screen & Media Filtration)	80%						
AquaShield	Aqua-Filter	Emerging Tech Herrera BMP database Caltrans B-46	Media Filtration/Hydrodynamic Separation	69% - 98%	92% - 97%			60% - 85%		60% - 85%
Arkal Filtration Systems	Arkal Filter	Herrera	Filtration (Disc)						99%	
Arkal Filtration Systems	Arkal Media Filter	Herrera CalTrans B-61	Filtration (Pressure)						99%	
BakerCorp	Baker Tank w/ Chitosan Enhanced Sand Filter	Herrera	Filtration (Chemical)	95%			50%	50%	50%	90%
BaySaver Technologies	BaySeparator	Emerging Tech Herrera	Hydrodynamic Separation	84% - 94%				42%		38%
BaySaver Technologies	BayFilter	Emerging Tech Herrera CalTrans B57	Media Filtration	80%			51%	41%	45%	38%
BioClean Environment System / Modular Wetland Systems, Inc.	Modular Wetland Linear	Emerging Tech Herrera	Bioretention/ Filtration	85% - 99%	99%	99%	50%	33% - 93%	79%	61% - 81%
BioClean Environmental	BioClean Curb Inlet Basket	Herrera	Drain Inlet Insert (Screen & Absorbent)	93%					79%	
BioClean Environmental	BioClean Environmental Downspout Filter	Herrera	Drain Inlet Insert (Screen & Absorbent)	93%		87%	76%		69%	
BioClean Environmental	BioClean Environmental Flume Filter	Herrera	Drain Inlet Insert (Screen & Absorbent)	29%	87%	83%				
BioClean Environmental	BioClean Environmental Grate Inlet Skimmer Box	Herrera	Drain Inlet Insert (Screen & Absorbent)	66%		95%	95%		95%	
BioClean Environmental	BioClean Water Polisher	Herrera	Media Filtration (Up-Flow)	85%	99%	91%		79%		78%
BioClean Environmental	Nutrient Separating Baffle Box	Herrera	Hydrodynamic Separation	87%		99%	41%		57%	
Bio-Microbics BioSTORM	BioSTORM	Herrera	OWS	95%						
Chitosan	Chitosan Enhanced Sand Filtration	Emerging Tech		97% - 99%						
Coanda	Coanda Downspout Filter	Herrera	Drain Inlet Insert (Screen & Media Filtration)	8%					69%	
Coanda	Coanda Inlet Filter	Herrera	Drain Inlet Insert (Screen & Media Filtration)	8%					69%	
Contech	Media Filtration System	Emerging Tech CalTrans B57		69% - 85%			57% - 61%		52% - 64%	
Contech	StormFilter with ZPG Media	Emerging Tech Herrera	Media Filtration	52% - 96%			47%	11%	62%	15%

TABLE C-1

TREATMENT TECHNOLOGY MASTER LIST

Manufacturer/Vendor	Treatment BMP[a]	BMP Source	Process Technology Type	Constituents Treated (% Reduced)[b][c]						
				TSS	TPH	Oil/ Grease	Total Copper	Dissolved Copper	Total Zinc	Dissolved Zinc
Contech	Vortechs	Emerging Tech Herrera CalTrans B-63	Hydrodynamic Separation	40% - 80%						
Contech	StormFilter with Metal RX Media	Emerging Tech Herrera	Media Filtration	68% - 95%				-3% - 97%		25% - 98%
Contech	Urban Green BioFilter	Emerging Tech Herrera Caltrans B-3 & 8	Bioretention/ Filtration	89% - 93%	84%		65%		83%	
Contech CDS	CDS	Emerging Tech Herrera CalTrans B-63	Hydrodynamic Separation	39% - 99%		27% - 92%				
Contech/Imbrium Systems	Jellyfish	Emerging Tech Herrera	Media Filtration	80% - 90%		62%	90%		70%	
DeepRoot Partners	Silva Cell	Herrera Caltrans B-3 & 8	Bioretention/ Filtration	80%			X	90%	X	90%
EcoSense International	EcoVault Baffle Box	Herrera	Drain Inlet Insert (Media Filtration)							
EcoSense International	Stormwater Filtration Systems	Herrera	Media Filtration (Cartridge)							
Eco-Tec	Adsorb-It	Herrera	Absorbent Boom/Fabric	80% - 99%	99% - 100%	99% - 100%				
Environment 21	V2B1 Treatment System	Emerging Tech Herrera CalTrans B-63	Hydrodynamic Separation	57% - 64%	63%	63%	40%		70%	
Environment 21	EnviroTrap CB Insert	Herrera	Drain Inlet Insert (Screen & Absorbent)	30%	63%	63%	9%		20%	
Environment 21	PuriStorm	Herrera CalTrans B57	Media Filtration (Cartridge)	80%	80%	80%	50%		80%	
Environment 21	UniScreen	Herrera	Hydrodynamic Separation	80%	63%	63%	20%		40%	
Environment 21	UniStorm	Herrera CalTrans B-63	Hydrodynamic Separation	80%	63%	63%	20%		40%	
Fabco Industries	StormBasin	Herrera	Drain Inlet Insert (Cartridge Media Filtration)	98%		90%			48%	
Fabco Industries	StormPod	Herrera	Drain Inlet Insert (Cartridge Media Filtration)	98%		90%			48%	
Hydro International	Downstream Defender	Emerging Tech Herrera CalTrans B-63	Hydrodynamic Separation	50% - 80%						
Hydro International	Up-Flo	Emerging Tech Herrera	Media Filtration	83% -92%			72%	30%	74%	60%
Hydroworks	HydroGuard	Herrera CalTrans B-63	Hydrodynamic Separation	70%						
Imbrium	Sorbtive FILTER	Herrera	Media Filtration (Cartridge)	84%						
Imbrium/Contech	Stormceptor	Emerging Tech Herrera CalTrans B-63	Hydrodynamic Separation	20% - 75%	73%			28%		35%
Kristar	FloGard Downspout Filter	Herrera	Drain Inlet Insert (Screen & Absorbent)	80%	80%	80%			60%	
Kristar	FloGard Dual-Vortex	Herrera CalTrans B-63	Hydrodynamic Separation	60%						
Kristar	FloGard LoPro Matrix Filter	Herrera	Drain Inlet Insert (Screen & Absorbent)	80%	80%	80%			60%	
Kristar	FloGard LoPro Trench Drain Filter	Herrera	Drain Inlet Insert (Screen & Absorbent)	80%	80%	80%			60%	

TABLE C-1

TREATMENT TECHNOLOGY MASTER LIST

Manufacturer/Vendor	Treatment BMP[a]	BMP Source	Process Technology Type	Constituents Treated (% Reduced)[b][c]						
				TSS	TPH	Oil/ Grease	Total Copper	Dissolved Copper	Total Zinc	Dissolved Zinc
Kristar	FloGard+PLUS	Herrera	Drain Inlet Insert (Screen & Absorbent)	80%	80%	80%			60%	
Kristar	SwaleGard Pre-filter	Herrera	Drain Inlet Insert (Screen & Absorbent)	80%	80%	80%			60%	
Kristar Enterprises	FloGard Perk Filter	Emerging Tech Herrera CalTrans B57	Media Filtration (Cartridge)	82% - 85%	75%	75%	62%		61%	
Lean Environment	Enpurion Metals Treatment	Emerging Tech	Media Filtration	90%			96%		99%	
Morselt Borne BV	Redbox	Herrera	Electrocoagulation	99%				99%		99%
OilTrap Environmental	OilTrap Environmental ElectroPulse	Herrera	Electrocoagulation	98%	100%	96%	99%	99%	99%	99%
Royal Environmental Systems	ecoStorm Plus	Emerging Tech Herrera CalTrans B-63	Media Filtration/Hydrodynamic Separation	84% - 85%			53%		57%	36%
Schreiber	Fuzzy Filter	Herrera	Media Filtration	70% - 95%						
StormwateRx	Aquip	Emerging Tech Caltrans B-46 Herrera	Media Filtration Bed	98%		70%	94%	73% - 93%	85%	59% - 94%
StormwateRx	Clara Gravity Stormwater Separator Vault	Herrera	OWS	47%			30%		32%	
StormwateRx	Purus Stormwater Polishing System	Herrera	Filtration (Chemical)						86%	88%
Terre Hill Concrete Products	Terre Kleen	Herrera and CalTrans B-63 and B-18	Hydrodynamic Separation- Plate & Tube Settlers	78%			X		X	
Torrent Resources	Maxwell Plus Drainage System	Emerging Tech		82%[g]						
Waste & Environmental Technologies	Wetsep	Herrera	Chemical Treatment	98%				86%		
Watertectonics	Wavelonics	Emerging Tech Herrera	Electrocoagulation	98%			100%	79%	94%	83%
Watertectonics ACISTBox	Watertectonics ACISTBox	Herrera	Chemical Treatment		88%		95%		51%	9%
WSDOT	Media Compost-Amended Biofiltration Swale	Emerging Tech		91%	73% - 81%			-44% - 74%		69% - 91%
WSDOT	Media Filter Drain	Emerging Tech		96%	81%			41%		81%
ABT First Flush	ABT First Flush	Herrera	OWS							
ACF Environmental Hydro-Kleen	ACF Environmental Hydro-Kleen	Herrera	Drain Inlet Insert (Media Filtration)							
AquaShield	Go-Filter	Herrera	Media Filtration (with Hydrodynamic Separation)							
AquaTech WaterTrak	AquaTech WaterTrak Pressurized Media Filter	Herrera	Media Filtration (Pressure)							
AquaTech WaterTrak	AquatTech WaterTrak Ultrafiltration	Herrera	Media Filtration							
AquaTech WaterTrak	AquaTech WaterTrak Ion Exchange	Herrera	Ion Exchange							
Arkal, Dynasand, Purimutit CD	CalTrans Filtration Pressure	CalTrans B-61	Filtration (Pressure)	X			X		X	
Austin, DC, Delaware	CalTrans Filtration Bed	CalTrans B-46 & C-11	Media Filtration (Sand Filter)	H			M	M	M	M
Bayfilter, perkfilter, Stormplex, Up-Flo, Media Filtration System, Puristorm, VortFilter	CalTrans Filtration Cartridge/Canister	CalTrans B57	Media Filtration (Cartridge)	X			X		X	
BioClean Environmental	BioClean Environmental Trench Drain Filter	Herrera	Drain Inlet Insert (Screen & Absorbent)							
Brown-Minneapolis Tank	Kleerwater	Herrera	OWS							
Clean Way	Clean Way Downspout Filtration Unit	Herrera	Drain Inlet Insert (Screen & Absorbent)							

TABLE C-1

TREATMENT TECHNOLOGY MASTER LIST

Manufacturer/Vendor	Treatment BMP[a]	BMP Source	Process Technology Type	Constituents Treated (% Reduced)[b][c]						
				TSS	TPH	Oil/ Grease	Total Copper	Dissolved Copper	Total Zinc	Dissolved Zinc
Clean Way	Clean Way StormClean Inlet Insert	Herrera	Drain Inlet Insert (Screen & Absorbent)							
Clean Way	Clean Way StormClean Wall Mount Filtration Unit	Herrera	Drain Inlet Insert (Screen & Absorbent)							
ClearWater Solutions ClearWater BMP	ClearWater Solutions ClearWater BMP	Herrera	Drain Inlet Insert (Screen & Media Filtration)							
Contech	Vortsentry	CalTrans B-63	Hydrodynamic Separation	X						
Contech	Contech VortClarex	Herrera	OWS							
Contech	Triton Drop Inlet Insert	Herrera	Drain Inlet Insert (Cartridge Media Filtration)							
CrystalStream Technologies	CrystalCombo Hybrid Polisher	Herrera	Media Filtration (with OWS)							
CrystalStream Technologies CrystalClean Separator	CrystalStream Technologies CrystalClean Separator	Herrera	OWS							
EcoSol Wastewater Filtration Systems RSF	EcoSol Wastewater Filtration Systems RSF	Herrera	Drain Inlet Insert (Screen & Media Filtration)							
Enviro-Drain	Enviro-Drain	Herrera	Drain Inlet Insert (Absorbent Boom/Fabric)							
Environmental Filtration Inc.	Raynfiltr	Herrera	Drain Inlet Insert (Media Filtration)							
Fabco Industries	StormSafe Helix	Herrera	Media Filtration (Cartridge)							
Hancor Storm PURE	Hancor Storm PURE	Herrera	Drain Inlet Insert (Screen & Absorbent)							
Hancor Storm Water Quality Unit	Hancor Storm Water Quality Unit	Herrera	OWS							
Huber Technology HUBER Hydro Filt	Huber Technology HUBER Hydro Filt	Herrera	Drain Inlet Insert (Media Filtration)							
Hydroworks	HydroFilter	Herrera CalTrans B-63	Media Filtration (with OWS)							
Kaselco High-Flo Electrocoagulation	Kaselco High-Flo Electrocoagulation	Herrera	Electrocoagulation							
Kristar	FloGard Trash & Debris Guard	Herrera	Drain Inlet Insert (Screen & Absorbent)							
Kristar	TREEPOD Biofilter	Herrera CalTrans B-3&8	Bioretention/ Filtration							
Non-Proprietary	Bioretention		Bioretention							
Non-Proprietary	CalTrans Chemical Treatment	CalTrans B-9		X						
Non-Proprietary	CalTrans Disinfection - Chemical Treatment	CalTrans B-27	Disinfection							
Non-Proprietary	CalTrans Disinfection Ultraviolet	CalTrans B-29	Disinfection							
Non-Proprietary	CalTrans Electrocoagulation	CalTrans B-11		X						
Non-Proprietary	CalTrans Infiltration Below Grade	CalTrans B-65	Infiltration	X			X	X	X	X
Non-Proprietary	CalTrans Inlet Insert Baffle Box	CalTrans B-31	Drain Inlet Insert	X						
Non-Proprietary	CalTrans Inlet Insert Basket/Box	CalTrans B-33-35	Drain Inlet Insert							
Non-Proprietary	CalTrans Inlet Insert Fabric	CalTrans B-37	Drain Inlet Insert	X						
Non-Proprietary	CalTrans Inlet Insert Media	CalTrans B-39	Drain Inlet Insert	X						
Non-Proprietary	CalTrans Inlet Insert Screen	CalTrans B-41	Drain Inlet Insert	X						
Non-Proprietary	CalTrans Inlet Insert Skimmer	CalTrans B-43	Drain Inlet Insert							
Non-Proprietary	CalTrans Plate and Tube Settlers	CalTrans B-17	Detention/ Sedimentation	X			X		X	
Non-Proprietary	CalTrans Porous Surface Asphalt Overlay	CalTrans B-69	Porous Surface	X			X		X	
Non-Proprietary	Cal Trans Screening Gross Solids Removal	CalTrans B-77	Screening							
Non-Proprietary	CalTrans Temporary Pool - Hold and Release	CalTrans B-21	Detention/ Sedimentation	X			X		X	
Non-Proprietary	CalTrans Temporary Pool - Infiltration Chambers	CalTrans B-23	Detention/ Sedimentation	X			X		X	

TABLE C-1

TREATMENT TECHNOLOGY MASTER LIST

Manufacturer/Vendor	Treatment BMP[a]	BMP Source	Process Technology Type	Constituents Treated (% Reduced)[b][c]						
				TSS	TPH	Oil/ Grease	Total Copper	Dissolved Copper	Total Zinc	Dissolved Zinc
Non-Proprietary	CalTrans Temporary Pool - Skimmer	CalTrans B-25	Detention/ Sedimentation	X			X		X	
Non-Proprietary	CalTrans Water Quality Inlet Oil/Water Separator	CalTrans B-79	Water Quality Inlet	X						
Non-Proprietary	T7.10 Infiltration Basins	SWMMWW[h] Volume V Section 7.4 & Caltrans C-15	Infiltration	H			H	H	H	H
Non-Proprietary	T7.20 Infiltration Trenches	SWMMWW Volume V Section 7.4 & Caltrans C-17	Infiltration	H			H	H	H	H
Non-Proprietary	T7.30 Biofiltration Cells, Swales and Planter Boxes	SWMMWW V V Sec 7.4								
Non-Proprietary	T7.40 Compost-Amended Vegetated Filter Strips	SWMMWW V V Sec 7.4								
Non-Proprietary	T8.10 Sand Filter Basin	SWMMWW V V Sec 8.5								
Non-Proprietary	T8.11 Large Sand Filter Basin	SWMMWW V V Sec 8.5								
Non-Proprietary	T8.20 Sand Filter Vault	SWMMWW V V Sec 8.5								
Non-Proprietary	T8.30 Linear Sand Filter	SWMMWW V V Sec 8.5								
Non-Proprietary	T8.40 Media Filter Drain	SWMMWW V V Sec 8.5								
Non-Proprietary	T9.10 Basic Biofiltration Swale	SWMMWW V V Sec 9.4 & Caltrans C-5		M			M	M	M	M
Non-Proprietary	T9.20 Wet Biofiltration Swale	SWMMWW V V Sec 9.4								
Non-Proprietary	T9.30 Continuous Inflow Biofiltration Swale	SWMMWW V V Sec 9.4								
Non-Proprietary	T9.40 Basic Filter Strip	SWMMWW V V Sec 9.4								
Non-Proprietary	T10.10 Wetpools - Basic and Large	SWMMWW V V Sec 10.3 & Caltrans C-27		H			H	M	H	M
Non-Proprietary	T10.20 Wetvault	SWMMWW V V Sec 10.3								
Non-Proprietary	T10.30 Stormwater Treatment Wetlands	SWMMWW V V Sec 10.3								
Non-Proprietary	T10.40 Combined Detention & Wetpool	SWMMWW V V Sec 10.3								
Non-Proprietary	T11.10 API (Baffle Type) Separator Bay	SWMMWW V V Sec 11.7	OWS							
Non-Proprietary	T11.11 Coalescing Plate OWS	SWMMWW V V Sec 11.7								
Non-Proprietary	CalTrans Linear Bioretention Trench	CalTrans B-5	Bioretention	X			X	X	X	X
Non-Proprietary	CalTrans Permanent Pool - Vegetated Rock Filter	CalTrans B-15	Detention/ Sedimentation	X			X	X	X	X
Nyloplast/Hancor SNOUT	Nyloplast/Hancor SNOUT	Herrera	OWS							
Park USA	StormTrooper	Herrera CalTrans B-63	Hydrodynamic Separation							
PSI International PSI Separator	PSI International PSI Separator	Herrera	OWS							
Rotondo Environmental Solutions Perimeter Sandfilter	Rotondo Environmental Solutions Perimeter Sandfilter	Herrera	Media Filtration (Sand Filter)							
Rotondo Environmental Solutions Underground Sandfilter	Rotondo Environmental Solutions Underground Sandfilter	Herrera	Media Filtration (Sand Filter)							

TABLE C-1

TREATMENT TECHNOLOGY MASTER LIST

Manufacturer/Vendor	Treatment BMP[a]	BMP Source	Process Technology Type	Constituents Treated (% Reduced)[b][c] TSS	TPH	Oil/ Grease	Total Copper	Dissolved Copper	Total Zinc	Dissolved Zinc
Royal Environmental Systems/Water Tectonics ecoLine	ecoLine	Herrera	OWS							
Royal Environmental Systems/Water Tectonics ecoSep	Royal Environmental Systems/Water Tectonics ecoSep	Herrera	OWS							
Royal Environmental Systems/Water Tectonics ecoTop	Royal Environmental Systems/Water Tectonics ecoTop	Herrera	OWS							
Siemens Wastewater Ion Exchange System	Siemens Wastewater Ion Exchange System	Herrera	Ion Exchange							
Stormdrain Solutions Inceptor	Stormdrain Solutions Inceptor	Herrera	Drain Inlet Insert (Screen & Absorbent)							
Stormfilter 400, Helix Filter, Jellyfish	CalTrans Filtration Fabric	CalTrans B-59	Filtration	X						
Transpo Industries EnviroSafe	Transpo Industries EnviroSafe	Herrera	Drain Inlet Insert (Media Filtration)							
Transpo Industries EnviroSafe Storm Safe	Transpo Industries EnviroSafe Storm Safe	Herrera	Drain Inlet Insert (Absorbent Boom/Fabric)							
United Storm Water DrainPac	United Storm Water DrainPac	Herrera	Drain Inlet Insert (Screen & Absorbent)							
Watertectonics pHATBox	Watertectonics pHATBox	Herrera	Chemical Treatment							
WaterTrak Reverse Osmosis	WaterTrak Reverse Osmosis	Herrera	Reverse Osmosis							

Listing Criteria:

Technologies are listed according to feasibility and alphabetically.

1) Technologies considered to be more feasible for use at marine terminals based on the criteria in Section 4 of the Manual are sorted closer to the top of the table with technologies considered to be less feasible near the bottom.
2) Technologies were then listed in each grouping alphabetically by manufacturer/vendor.

Notes:

(a) Note that each best management practice (BMP) listed may include additional and associated BMPs defined in applicable guidance documents. Technologies with a range of pollutant reduction efficiency in the referenced documents were sorted based on the upper range value.

(b) Percent reduction data is based on vendor conducted and reported studies reported in the listed reference documents, as indicated by color coding below. Little reduction data exists for turbidity and chemical oxygen demand, so these parameters were not included in this table.

(c) If the reference documents include a fractional percent reduction for a tested pollutant of concern, the percent reduction was rounded to the nearest whole number.

(d) Emerging Tech = Performance data compiled from published Use Level Designation documents posted to Ecology's Stormwater Treatment Tenologies Website: http://www.ecy.wa.gov/programs/wq/stormwater/newtech/technologies.html

(e) Herrera = Performance data compiled from Ecology Publication: Literature Review of Existing Treatment Technologies for Industrial Stormwater (Herrera Environmental Consultants, July 2011)

(f) CalTrans Treatment BMP Technology Report, April 2010.
PURPLE X indicates that the Caltrans report states that the removal efficiency of an unapproved BMP is statistically significant or expected to be based upon best professional judgment.
PURPLE H, M, L indicates that the Caltrans report states that the constituent removal efficiency is high, medium, or low based upon best professional judgment.

(g) Percent reduction was calculated based on reported average influent and effluent concentrations.

(h) SWMMWW = Stormwater Management Manual for Western Washington Volume V, August 2012

Cu = copper
Zn = zinc
TSS = total suspended solids
TPH = total petroleum hydrocarbons
OWS = oil/water separation

TABLE C-2

ECOLOGY USE LEVEL DESIGNATION

Manufacturer/Vendor[a]	Treatment BMP[b]	Ecology Use Level Designation(c)				Technology Type
		Oil	Enhanced (Dissolved Cu & Zn)	Basic (TSS)	Pretreatment/ Construction	
Americast	Filterra	GULD[d]	GULD	GULD		Bioretention/ Filtration
AquaShield	AquaSwirl			CULD[e]	GULD-P	Hydrodynamic Separation
AquaShield	Aqua-Filter	PULD	PULD	PULD		Media Filtration/Hydrodynamic Separation
BaySaver Technologies	BaySeparator				CULD-P	Hydrodynamic Separation
BaySaver Technologies	BayFilter		CULD	GULD		Media Filtration
BioClean Environment System / Modular Wetland Systems, Inc.	Modular Wetland Linear		GULD	GULD		Bioretention/ Filtration
Chitosan	Chitosan Enhanced Sand Filtration				GULD-C	
Contech	Media Filtration System			GULD		
Contech	StormFilter with ZPG Media			GULD		Media Filtration
Contech	Vortechs				GULD-P	Hydrodynamic Separation
Contech	StormFilter with Metal RX Media		CULD	CULD		Media Filtration
Contech	Urban Green BioFilter	PULD	PULD	CULD		Bioretention/ Filtration
Contech CDS	CDS	PULD			GULD-P	Hydrodynamic Separation
Contech/Imbrium Systems	Jellyfish	PULD		CULD		Media Filtration
Environment 21	V2B1 Treatment System				PULD-P	Hydrodynamic Separation
Hydro International	Downstream Defender				GULD-P	Hydrodynamic Separation
Hydro International	Up-Flo			CULD		Media Filtration
Imbrium/Contech	Stormceptor				GULD-P	Hydrodynamic Separation
Kristar Enterprises	FloGard Perk Filter			GULD		Media Filtration (Cartridge)
Lean Environment	Enpurion Metals Treatment		CULD	CULD		Media Filtration
Royal Environmental Systems	ecoStorm Plus			GULD		Media Filtration/Hydrodynamic Separation
StormwateRx	Aquip		CULD	CULD		Media Filtration Bed
Torrent Resources	Maxwell Plus Drainage System	PULD		PULD		
Watertectonics	WaveIonics				GULD-C	Electrocoagulation
WSDOT	Media Compost-Amended Biofiltration Swale	CULD	GULD	GULD		
WSDOT	Media Filter Drain		GULD	GULD		

Notes:

(a) Technologies are listed alphabetically by manufacturer or vendor company name.

(b) Manufacturer/vendor treatment system product name.

(c) Ecology Use Level Designation as listed on Ecology's Stormwater Treatment Technologies Website:
http://www.ecy.wa.gov/programs/wq/stormwater/newtech/technologies.html

GULD = General Use Level Designation
CULD = Conditional Use Level Designation
PULD = Pilot Use Level Designation

(d) Ecology GULD is listed for treatment technologies identified to meet the following pollutant reduction goals:

Pretreatment (GULD-P, PULD-P, CULD-P)

Concentration >100 milligrams/liter (mg/L) but <200 mg/L: 50% removal of fine (50 micron-mean size) and 80% removal of coarse (125-micron-mean size) total suspended solids (TSS).

Concentration <100 mg/L: achieve effluent goals of 50 mg/L of fine and 20 mg/L of coarse TSS.

Construction (GULD-C)

Construction treatment is intended to achieve the goals of a maximum of 5 nephelometric turbidity unit (NTU) above background (background of 50 NTUs or less), not more than 10% increase in trubidity where background is greater than 50 NTUs, pH of 6.5 to 8.5 in freshwater and 7.0 to 8.5 in marine water, and no visibile oil sheen.

Oil Treatment

Intended to achieve the goals of no ongoing or recurring visible sheen and a daily average total petroleum hydrocarbon concentration no greater than 10 mg/L with a maximum of 15 mg/L for discrete (grab) samples.

Basic Treatment

Achieve a goal of 80% removal of TSS for an influent concentration range of 100 mg/L to 200 mg/L.

For influent concentration less than 100 mg/L the effluent goal is 20 mg/L TSS.

For influent concentrations greater than 200 mg/L a higher treatment goal is intended. Technologies listed in this section with a GULD designation are also approved for pretreatment in accordance with the Ecology Stormwater Management Manuals for Eastern and Western Washington.

Enhanced Treatment

Intended to achieve a higher level of treatment than basic treatment. Enhanced treatment is targeted at removing dissolved metals.

(e) CULD or PULD technologies are included in Ecology's Technology Assessment Protocol - Ecology (TAPE) program. Ecology does not recognize any identified performance claims for PULD and CULD technologies.

Cu = copper
Zn = zinc

TABLE C-3

TREATMENT TECHNOLOGY LISTING
TOTAL ZINC

Permittees are encouraged to investigate all of the stormwater treatment technologies and approaches listed in Table C-1 that may be appropriate to reduce facility stormwater discharge pollutant parameters to below Industrial Stormwater General Permit (ISGP) benchmark levels. Several non-proprietary approaches are included in Table C-1 that do not appear in this Table as applicable pollutant reduction data for all of the stormwater treatment best management practices (BMPs) listed in Table C-1 were not readily available. Permittees should focus on the qualitative and quantitative criteria discussed in Section 5 of this Manual considering site feasibility, specific pollutants to be addressed, capital and operation and management (O&M) cost considerations, as well as sustainability of approach when selecting appropriate stormwater treatment BMPs for implementation at their facilities. Incorporation of Low Impact Development (LID), green infrastructure principals should be considered first, to maximize overall environmental benefit and to limit adverse environmental impacts resulting from Level 3 Corrective Actions. In many cases, the correct stormwater treatment strategy to address ISGP Level 3 Corrective Action requirements will include non-proprietary solutions.

	Manufacturer/Vendor	Treatment BMP[a]	BMP Source	Process Technology Type	Constituents Treated (% Reduction)[b][c] Total Zinc	Dissolved Zinc
High	Arkal Filtration Systems	Arkal Filter	Herrera[d]	Filtration (Disc)	99%	
	Arkal Filtration Systems	Arkal Media Filter	Herrera CalTrans B-61[f]	Filtration (Pressure)	99%	
	Lean Environment	Enpurion Metals Treatment	Emerging Tech[d]	Media Filtration	99%	
	OilTrap Environmental	OilTrap Environmental ElectroPulse	Herrera	Electrocoagulation	99%	99%
	BioClean Environmental	BioClean Environmental Grate Inlet Skimmer Box	Herrera	Drain Inlet Insert (Screen and Absorbent)	95%	
	Watertectonic	WaveIonics	Herrera	Electrocoagulation	94%	83%
	StormwateRx	Purus Stormwater Polishing System	Herrera	Filtration (Chemical)	86%	88%
	StormwateRx	Aquip	Emerging Tech Caltrans B-46 Herrera	Media Filtration Bed	85%	59% - 94%
	Contech	Urban Green BioFilter	Emerging Tech Herrera Caltrans B-3 & 8	Bioretention/ Filtration	83%	
	Environment 21	PuriStorm	Herrera CalTrans B57	Media Filtration (Cartridge)	80%	
	BioClean Environmental	BioClean Curb Inlet Basket	Herrera	Drain Inlet Insert (Screen and Absorbent)	79%	
	BioClean Environment System / Modular Wetland Systems, Inc.	Modular Wetland Linear	Emerging Tech Herrera	Bioretention/ Filtration	79%	61% - 81%
	ADS Water Quality Unit	ADS Water Quality Unit	Herrera	OWS	74%	74%
	Hydro International	Up-Flo	Emerging Tech Herrera	Media Filtration	74%	60%
Medium	Contech/Imbrium Systems	Jellyfish	Emerging Tech Herrera	Media Filtration	70%	
	Environment 21	V2B1 Treatment System	Emerging Tech Herrera CalTrans B-63	Hydrodynamic Separation	70%	
	BioClean Environmental	BioClean Environmental Downspout Filter	Herrera	Drain Inlet Insert (Screen and Absorbent)	69%	
	Coanda	Coanda Downspout Filter	Herrera	Drain Inlet Insert (Screen and Media Filtration)	69%	
	Coanda	Coanda Inlet Filter	Herrera	Drain Inlet Insert (Screen and Media Filtration)	69%	
	Contech	Media Filtration System	Emerging Tech CalTrans B57		52% - 64%	
	Contech	StormFilter with ZPG Media	Emerging Tech Herrera	Media Filtration	62%	15%
	Kristar Enterprises	FloGard Perk Filter	Emerging Tech Herrera CalTrans B57	Media Filtration (Cartridge)	61%	
	Kristar	FloGard Downspout Filter	Herrera	Drain Inlet Insert (Screen and Absorbent)	60%	

TABLE C-3

TREATMENT TECHNOLOGY LISTING
TOTAL ZINC

	Manufacturer/Vendor	Treatment BMP[a]	BMP Source	Process Technology Type	Constituents Treated (% Reduction)[b][c] Total Zinc	Dissolved Zinc
Medium	Kristar	FloGard LoPro Matrix Filter	Herrera	Drain Inlet Insert (Screen and Absorbent)	60%	
	Kristar	FloGard LoPro Trench Drain Filter	Herrera	Drain Inlet Insert (Screen and Absorbent)	60%	
	Kristar	FloGard+PLUS	Herrera	Drain Inlet Insert (Screen and Absorbent)	60%	
	Kristar	SwaleGard Pre-filter	Herrera	Drain Inlet Insert (Screen and Absorbent)	60%	
	BioClean Environmental	Nutrient Separating Baffle Box	Herrera	Hydrodynamic Separation	57%	
	Royal Environmental Systems	ecoStorm Plus	Emerging Tech Herrera CalTrans B-63	Media Filtration/Hydrodynamic Separation	57%	36%
	Americast	Filterra	Emerging Tech Herrera CalTrans B-3&8	Bioretention/ Filtration	56%	54%
	Watertectonics ACISTBox	Watertectonics ACISTBox	Herrera	Chemical Treatment	51%	9%
	BakerCorp	Baker Tank w/ Chitosan Enhanced Sand Filter	Herrera	Filtration (Chemical)	50%	90%
Low	Fabco Industries	StormBasin	Herrera	Drain Inlet Insert (Cartridge Media Filtration)	48%	
	Fabco Industries	StormPod	Herrera	Drain Inlet Insert (Cartridge Media Filtration)	48%	
	BaySaver Technologies	BayFilter	Emerging Tech Herrera CalTrans B57	Media Filtration	45%	
	Environment 21	UniScreen	Herrera	Hydrodynamic Separation	40%	
	Environment 21	UniStorm	Herrera CalTrans B-63	Hydrodynamic Separation	40%	
	StormwateRx	Clara Gravity Stormwater Separator Vault	Herrera	OWS	32%	

Listing Criteria:

Treatment technologies are sorted in descending order based on estimated pollutant reduction efficiency listed in the referenced resources. Technologies with equal listed pollutant reduction percentages were additionally sorted alphabetically. Technologies with a range of pollutant reduction efficiency in the referenced documents were sorted based on the upper range value.

Notes:

(a) Note that each best management practice (BMP) listed may include additional and associated BMPs defined in the listed guidance documents.

(b) Percent reduction data is based on vendor conducted and reported studies reported in the listed reference documents, as indicated by color coding below.

(c) If the reference documents include a fractional percent reduction for a tested pollutant of concern, the percent reduction was rounded to the nearest whole number.

(d) Herrera = Performance data compiled from Ecology Publication: Literature Review of Existing Treatment Technologies for Industrial Stormwater (Herrera Environmental Consultants, July 2011).

(e) Emerging Tech = Performance data compiled from published Use Level Designation documents posted to Ecology's Stormwater Treatment Tenologies Website: http://www.ecy.wa.gov/programs/wq/stormwater/newtech/technologies.html.

(f) CalTrans Treatment BMP Technology Report, April 2010.

Treatment systems in these categories are considered to be appropriate given permittee effluent data in the high, medium, and low categories defined in the Treatment System Performance Categories for Selected Parameters included in Section 4 of the Manual.

TABLE C-4

TREATMENT TECHNOLOGY LISTING
TOTAL COPPER

Permittees are encouraged to investigate all of the stormwater treatment technologies and approaches listed in Table C-1 that may be appropriate to reduce facility stormwater discharge pollutant parameters to below Industrial Stormwater General Permit (ISGP) benchmark levels. Several non-proprietary approaches are included in Table C-1 that do not appear in this table as applicable pollutant reduction data for all of the stormwater treatment best managment practices (BMPs) listed in Table C-1 were not readily available. Permittees should focus on the qualitative and quantitative criteria discussed in Section 5 of this Manual considering site feasibility, specific pollutants to be addressed, capital and operation and management (O&M) cost considerations, as well as sustainability of approach when selecting appropriate stormwater treatment BMPs for implementation at their facilities. Incorporation of Low Impact Development (LID), green infrastructure principals should be considered first, to maximize overall environmental benefit and to limit adverse environmental impacts resulting from Level 3 Corrective Actions. In many cases, the correct stormwater treatment strategy to address ISGP Level 3 Corrective Action requirements will include non-proprietary solutions.

	Manufacturer/Vendor	Treatment BMP[a]	BMP Source	Process Technology Type	Constituents Treated (% Reduction)[b],[c] Total Copper	Dissolved Copper
High	Watertectonics	WaveIonics	Herrera[d]	Electrocoagulation	100%	79%
	OilTrap Environmental	OilTrap Environmental ElectroPulse	Herrera	Electrocoagulation	99%	99%
	Lean Environment	Enpurion Metals Treatment	Emerging Tech[e]	Media Filtration	96%	
	BioClean Environmental	BioClean Environmental Grate Inlet Skimmer Box	Herrera	Drain Inlet Insert (Screen and Absorbent)	95%	
	Watertectonics ACISTBox	Watertectonics ACISTBox	Herrera	Chemical Treatment	95%	
	StormwateRx	Aquip	Emerging Tech Caltrans B-46[f] Herrera	Media Filtration Bed	94%	73% - 93%
	Contech/Imbrium Systems	Jellyfish	Emerging Tech Herrera	Media Filtration	90%	
	Americast	Filterra	Emerging Tech Herrera CalTrans B-3 & 8	Bioretention/Filtration	82% - 84%	40%
	BioClean Environmental	BioClean Environmental Downspout Filter	Herrera	Drain Inlet Insert (Screen and Absorbent)	76%	
	ADS Water Quality Unit	ADS Water Quality Unit	Herrera	OWS	74%	74%
	Hydro International	Up-Flo	Emerging Tech Herrera	Media Filtration	72%	30%
Medium	Contech	Urban Green BioFilter	Emerging Tech Herrera Caltrans B-3 & 8	Bioretention/Filtration	65%	
	Kristar Enterprises	FloGard Perk Filter	Emerging Tech Herrera CalTrans B57	Media Filtration (Cartridge)	62%	
	Contech	Media Filtration System	Emerging Tech CalTrans B57		57% - 61%	
	Royal Environmental Systems	ecoStorm Plus	Emerging Tech Herrera CalTrans B-63	Media Filtration/Hydrodynamic Separation	53%	
	BaySaver Technologies	BayFilter	Emerging Tech Herrera CalTrans B57	Media Filtration	51%	41%
	BakerCorp	Baker Tank w/ Chitosan Enhanced Sand Filter	Herrera	Filtration (Chemical)	50%	50%
	BioClean Environment System / Modular Wetland Systems, Inc.	Modular Wetland Linear	Emerging Tech Herrera	Bioretention/ Filtration	50%	33% - 93%
	Environment 21	PuriStorm	Herrera CalTrans B57	Media Filtration (Cartridge)	50%	

TABLE C-4

TREATMENT TECHNOLOGY LISTING
TOTAL COPPER

	Manufacturer/Vendor	Treatment BMP[a]	BMP Source	Process: Technology Type	Constituents Treated (% Reduction)[b],[c]: Total Copper	Constituents Treated (% Reduction)[b],[c]: Dissolved Copper
Low	Contech	StormFilter with ZPG Media	Emerging Tech Herrera	Media Filtration	47%	11%
Low	BioClean Environmental	Nutrient Separating Baffle Box	Herrera	Hydrodynamic Separation	41%	
Low	Environment 21	V2B1 Treatment System	Emerging Tech Herrera CalTrans B-63	Hydrodynamic Separation	40%	
Low	StormwateRx	Clara Gravity Stormwater Separator Vault	Herrera	OWS	30%	

Listing Criteria:

Treatment technologies are sorted in descending order based on estimated pollutant reduction efficiency listed in the referenced resources. Technologies with equal listed pollutant reduction percentages were additionally sorted alphabetically. Technologies with a range of pollutant reduction efficiency in the referenced documents were sorted based on the upper range value.

Notes:

(a) Note that each best management practice (BMP) listed may include additional and associated BMPs defined in the listed guidance documents.

(b) Percent reduction data is based on vendor conducted and reported studies reported in the listed reference documents, as indicated by color coding below.

(c) If the reference documents include a fractional percent reduction for a tested pollutant of concern, the percent reduction was rounded to the nearest whole number.

(d) Herrera = Performance data compiled from Ecology Publication: Literature Review of Existing Treatment Technologies for Industrial Stormwater (Herrera Environmental Consultants, July 2011).

(e) Emerging Tech = Performance data compiled from published Use Level Designation documents posted to Ecology's Stormwater Treatment Tenologies Website: http://www.ecy.wa.gov/programs/wq/stormwater/newtech/technologies.html.

(f) CalTrans Treatment BMP Technology Report, April 2010.

Treatment systems in these categories are considered to be appropriate given permittee effluent data in the high, medium, and low categories defined in the Treatment System Performance Categories for Selected Parameters included in Section 4 of the Manual.

TABLE C-5

TREATMENT TECHNOLOGY LISTING
TOTAL SUSPENDED SOLIDS (TSS)

Permittees are encouraged to investigate all of the stormwater treatment technologies and approaches listed in Table C-1 that may be appropriate to reduce facility stormwater discharge pollutant parameters to below Industrial Stormwater General Permit (ISGP) benchmark levels. Several non-proprietary approaches are included in Table C-1 that do not appear in this table as applicable pollutant reduction data for all of the stormwater treatment best management practices (BMPs) listed in Table C-1 were not readily available. Permittees should focus on the qualitative and quantitative criteria discussed in Section 5 of this Manual considering site feasibility, specific pollutants to be addressed, capital and operation and managment (O&M)cost considerations, as well as sustainability of approach when selecting appropriate stormwater treatment BMPs for implementation at their facilities. Incorporation of Low Impact Development (LID), green infrastructure principals should be considered first, to maximize overall environmental benefit and to limit adverse environmental impacts resulting from Level 3 Corrective Actions. In many cases, the correct stormwater treatment strategy to address ISGP Level 3 Corrective Action requirements will include non-proprietary solutions.

	Manufacturer/Vendor	Treatment BMP[a]	BMP Source	Process Technology Type	Constituents Teated (% Reduction)[b],[c] TSS
High	BioClean Environment System / Modular Wetland Systems, Inc.	Modular Wetland Linear	Emerging Tech[d] Herrera	Bioretention/Filtration	85% - 99%
	Contech CDS	CDS	Emerging Tech Herrera CalTrans B-63	Hydrodynamic Separation	39% - 99%
	Chitosan	Chitosan Enhanced Sand Filtration	Emerging Tech		97% - 99%
	Eco-Tec	Adsorb-It	Herrera	Absorbent Boom/Fabric	80% - 99%
	Morselt Borne BV	Redbox	Herrera[e]	Electrocoagulation	99%
	AquaShield	Aqua-Filter	Emerging Tech & Herrera BMP database Caltrans B-46	Media Filtration/Hydrodynamic Separation	69% - 98%
	Fabco Industries	StormBasin	Herrera	Drain Inlet Insert (Cartridge Media Filtration)	98%
	Fabco Industries	StormPod	Herrera	Drain Inlet Insert (Cartridge Media Filtration)	98%
	OilTrap Environmental	OilTrap Environmental ElectroPulse	Herrera	Electrocoagulation	98%
	StormwateRx	Aquip	Emerging Tech Caltrans B-46[f] Herrera	Media Filtration Bed	98%
	Waste & Environmental Technologies	Wetsep	Herrera	Chemical Treatment	98%
	Watertectonics	WaveIonics	Emerging Tech Herrera	Electrocoagulation	98%
	Americast	Filterra	Emerging Tech Herrera CalTrans B-3&8	Bioretention/ Filtration	70% - 96%
	Contech	StormFilter with ZPG Media	Emerging Tech Herrera	Media Filtration	52% - 96%
	WSDOT	Media Filter Drain	Emerging Tech		96%
	BakerCorp	Baker Tank w/ Chitosan Enhanced Sand Filter	Herrera	Filtration (Chemical)	95%
	Bio-Microbics BioSTORM	BioSTORM	Herrera	OWS	95%
	Contech	StormFilter with Metal RX Media	Emerging Tech Herrera	Media Filtration	68% - 95%
	Schreiber	Fuzzy Filter	Herrera	Media Filtration	70% - 95%
	BaySaver Technologies	BaySeparator	Emerging Tech Herrera	Hydrodynamic Separation	84% - 94%
	BioClean Environmental	BioClean Curb Inlet Basket	Herrera	Drain Inlet Insert (Screen and Absorbent)	93%
	BioClean Environmental	BioClean Environmental Downspout Filter	Herrera	Drain Inlet Insert (Screen and Absorbent)	93%
	Hydro International	Up-Flo	Emerging Tech Herrera	Media Filtration	83% - 92%
	AquaShield	AquaSwirl	Emerging Tech Herrera CalTrans B-63	Hydrodynamic Separation	80% - 91%

TABLE C-5

TREATMENT TECHNOLOGY LISTING
TOTAL SUSPENDED SOLIDS (TSS)

	Manufacturer/Vendor	Treatment BMP[a]	BMP Source	Process Technology Type	Constituents Teated (% Reduction)[b],[c] TSS
High	WSDOT	Media Compost-Amended Biofiltration Swale	Emerging Tech		91%
	Contech/Imbrium Systems	Jellyfish	Emerging Tech Herrera	Media Filtration	80% - 90%
	Lean Environment	Enpurion Metals Treatment	Emerging Tech	Media Filtration	90%
	BioClean Environmental	Nutrient Separating Baffle Box	Herrera	Hydrodynamic Separation	87%
	BioClean Environmental	BioClean Water Polisher	Herrera	Media Filtration (Up-Flow)	85%
	Contech	Media Filtration System	Emerging Tech CalTrans B57		69% - 85%
	Kristar Enterprises	FloGard Perk Filter	Emerging Tech Herrera CalTrans B57	Media Filtration (Cartridge)	82% - 85%
	Royal Environmental Systems	ecoStorm Plus	Emerging Tech Herrera CalTrans B-63	Media Filtration/Hydrodynamic Separation	84% - 85%
	Imbrium	Sorbtive FILTER	Herrera	Media Filtration (Cartridge)	84%
	Torrent Resources	Maxwell Plus Drainage System	Emerging Tech		82%[g]
	Abtech Industries	Ultra-Urban Filter	Herrera	Drain Inlet Insert (Absorbent Boom/Fabric)	80%
	ADS Water Quality Unit	ADS Water Quality Unit	Herrera	OWS	80%
	AquaShield	Aqua-Guardian CB Insert	Herrera	Drain Inlet Insert (Screen and Media Filtration)	80%
	BaySaver Technologies	BayFilter	Emerging Tech Herrera CalTrans B57	Media Filtration	80%
	Contech	Vortechs	Emerging Tech Herrera CalTrans B-63	Hydrodynamic Separation	40% - 80%
	DeepRoot Partners	Silva Cell	Herrera Caltrans B-3 & 8	Bioretention/Filtration	80%
	Environment 21	PuriStorm	Herrera CalTrans B57	Media Filtration (Cartridge)	80%
	Environment 21	UniScreen	Herrera	Hydrodynamic Separation	80%
	Environment 21	UniStorm	Herrera CalTrans B-63	Hydrodynamic Separation	80%
	Hydro International	Downstream Defender	Emerging Tech Herrera CalTrans B-63	Hydrodynamic Separation	50% - 80%
	Kristar	FloGard Downspout Filter	Herrera	Drain Inlet Insert (Screen and Absorbent)	80%
	Kristar	FloGard LoPro Matrix Filter	Herrera	Drain Inlet Insert (Screen and Absorbent)	80%
	Kristar	FloGard LoPro Trench Drain Filter	Herrera	Drain Inlet Insert (Screen and Absorbent)	80%
	Kristar	FloGard+PLUS	Herrera	Drain Inlet Insert (Screen and Absorbent)	80%
	Kristar	SwaleGard Pre-filter	Herrera	Drain Inlet Insert (Screen and Absorbent)	80%
Medium	Terre Hill Concrete Products	Terre Kleen	Herrera and CalTrans B-63 and B-18	Hydrodynamic Separation - Plate and Tube Settlers	78%
	Imbrium/Contech	Stormceptor	Emerging Tech		20% - 75%
	Hydroworks	HydroGuard	Herrera CalTrans B-63	Hydrodynamic Separation	70%
	BioClean Environmental	BioClean Environmental Grate Inlet Skimmer Box	Herrera	Drain Inlet Insert (Screen and Absorbent)	66%
	Environment 21	V2B1 Treatment System	Emerging Tech Herrera CalTrans B-63	Hydrodynamic Separation	57% - 64%
	Kristar	FloGard Dual-Vortex	Herrera CalTrans B-63	Hydrodynamic Separation	60%

TABLE C-5

TREATMENT TECHNOLOGY LISTING
TOTAL SUSPENDED SOLIDS (TSS)

	Manufacturer/Vendor	Treatment BMP[a]	BMP Source	Process Technology Type	Constituents Teated (% Reduction)[b],[c] TSS
Low	StormwateRx	Clara Gravity Stormwater Separator Vault	Herrera	OWS	47%
	Environment 21	EnviroTrap CB Insert	Herrera	Drain Inlet Insert (Screen and Absorbent)	30%

Listing Criteria:

Treatment technologies are sorted in descending order based on estimated pollutant reduction efficiency listed in the referenced resources. Technologies with equal listed pollutant reduction percentages were additionally sorted alphabetically. Technologies with a range of pollutant reduction efficiency in the referenced documents were sorted based on the upper range value.

Notes:

(a) Note that each best management practice (BMP) listed may include additional and associated BMPs defined in the listed guidance documents.
(b) Percent reduction data is based on vendor conducted and reported studies reported in the listed reference documents, as indicated by color coding below.
(c) If the reference documents include a fractional percent reduction for a tested pollutant of concern, the percent reduction was rounded to the nearest whole number.
(d) Herrera = Performance data compiled from Ecology Publication: Literature Review of Existing Treatment Technologies for Industrial Stormwater (Herrera Environmental Consultants, July 2011).
(e) Emerging Tech = Performance data compiled from published Use Level Designation documents posted to Ecology's Stormwater Treatment Tenologies Website: http://www.ecy.wa.gov/programs/wq/stormwater/newtech/technologies.html.
(f) CalTrans Treatment BMP Technology Report, April 2010.
(g) Percent reduction was calculated based on reported average influent and effluent concentrations.

Treatment systems in these categories are considered to be appropriate given permittee effluent data in the high, medium, and low categories defined in the Treatment System Performance Categories for Selected Parameters included in Section 4 of the Manual.

Appendix D

Pollutant Source Characterization Guidance

Appendix D: Pollutant Source Characterization Guidance

This Appendix provides guidance to facility operators on potential source characterization activities to implement at their facilities. Identifying sources is required by the Industrial Stormwater General Permit (ISGP) and is paramount to controlling sources as efficiently as possible. Focusing best management practice (BMP) implementation at the source of pollutants will reduce compliance costs, including the areas of the facility where more expensive controls, such as treatment, may be required. Since facility operations may change over time, it is recommended that periodic review of pollutant sources be performed. Additional source characterization may also assist the corrective action process if triggered.

Many pollutant sources are obvious or apparent, based on facility operations or materials. Common pollutant sources to marine terminal operations include hydrocarbons and metals in hydraulic and motor oil, as well as solids/turbidity caused by dirt and air particulate deposition. At waterfront log yards, bark and other solids that fall off the logs themselves contribute significant amounts of turbidity, suspended solids, and chemical oxygen demand (COD) to stormwater.

In recent years, other pollutant sources have been found to be widespread and common at marine terminal facilities in brake pads, paints/coatings, and in galvanized products, such as fencing. Facility operators are encouraged to reference Washington State Department of Ecology (Ecology) guidance on identifying and controlling sources of zinc at industrial facilities (**A Survey of Zinc Concentrations in Industrial Stormwater Runoff, Ecology January 2006 and Suggested Practices to Reduce Zinc Concentrations in Industrial Stormwater Discharges, Ecology June 2008**). Primary sources of copper include paints and coatings, as well as brake pads.

D.1 Common Pollutant Sources

Primary sources of typical pollutants of concern at many marine terminals include:

- **Atmospheric deposition**. Due to the typical location of marine terminals near major urban thoroughfares, pollutants from the surrounding areas and activities are present in the air. Pollutants from air deposition (such as zinc and copper) settle on facility surfaces and become comingled with stormwater.

- **Vehicles**. At many facilities, a large volume of traffic consists of vehicles not owned by the facility that enter the facility to deliver or pick up commodities and materials. During peak activity it is not unusual for up to 2,000 gate transactions (entering and exiting terminals) to occur per day.

  Marine terminals typically own and operate numerous vehicles to move commodities, materials, and equipment around the facility. These vehicles may include top picks, side picks, hostlers, bomb carts, forklifts, rubber-tired gantry cranes (RTGs), straddle carriers, fueling trucks, truck chassis, man lifts, pickup trucks, log stackers, transport vans, etc.. Because the majority of these vehicles are limited to travel within the terminals, their tracking in of offsite pollutants is not a primary concern though tire wear can be a significant contribution to turbidity and zinc.

Pollutants from vehicles include the following:

- Copper, zinc, dirt, and other debris from the surrounding roadways (described above) that adheres to vehicle undercarriages and tires and is tracked into terminals.
- Copper (and zinc to a lesser extent) particulates from vehicles with copper brake pads. Some vehicles such as top picks and side picks have "wet brakes" (encapsulated rotors in an oil bath) and no exposed brake pads.
- Zinc particulate from the use of onsite equipment handling equipment and vehicle tires and dissolved zinc from oils and greases. Fine rubber generated from normal equipment tire wear also can cause turbidity.

- **Galvanized building materials and fencing**. Most facilities have significant lengths of galvanized fencing, up to 3 miles at some facilities. Galvanized fencing and other galvanized building materials are known sources of zinc measured to contribute zinc in the mg/L level.

- **Maintenance areas**. Maintenance and repair areas typically have higher concentrations of pollutants, including copper, zinc, turbidity, and oil due to maintenance activities, storage of materials, and high traffic volumes.

- **Painted surfaces**. Paint typically includes zinc, which may leach into stormwater over time, as a part of its mixture. The concentration of zinc varies by paint manufacturer and the year it was produced. However, zinc is a common antioxidant used in paints for materials that will be exposed to salt air, such as shipping containers. At many facilities, the primary painted surfaces that may contain zinc and/or copper and include the following:
  - Commodities and materials brought into facilities by cargo ships and trucks. These containers are typically not owned by the facilities and the types and condition of paints on the materials vary.
  - Light pole bases, transformer enclosures, and other site fixtures or equipment.
  - Building materials.

- **Building roofs**. Roofs of buildings at marine terminals may be galvanized metal or painted with zinc-containing paint and may contribute zinc to the stormwater. Composite roofing materials are commonly treated with copper to inhibit moss growth. However, due to high amounts of air deposition of particulates in most industrial and urban areas, the roofing materials alone are not the only source of pollutants in roof runoff.

  Other potential sources of pollutants may include potential inflow of contaminated soil and groundwater and legacy solids that are present in some stormwater conveyance systems due to the age and integrity of the pipes.

D.2 Source Characterization Methods

The source characterization guidance presented here is general, not industry-specific, and may be implemented at any type of marine terminal facility. It is designed to identify areas of a facility that may be problematic compared to others and is especially helpful to identify historical

or unknown sources of pollutants. The process starts with understanding your facility, creating a baseline condition to compare new information to be obtained through sampling, and further refinement to identify sources through a process of elimination through sampling within a drainage basin. The following steps, in the order presented, are recommended to better identify sources of pollutants to stormwater.

- **Define coverage area**. Determine what portion of the facility is subject to ISGP coverage and implementation of operational and structural source control and treatment BMPs, monitoring, and inspections.

- **Generate/verify drainage system maps (video, smoke, and/or dye testing)**. Most stormwater conveyance systems were designed to channel water away from paved surfaces and to receiving waters as quickly as possible. Many systems have been added to or modified from their original construction. It is likely that historical maps of the drainage system are incorrect. Verifying drainage flow and direction patterns is key to designing proper control and treatment systems. Smoke, dye, and video testing are all available to help define how drainage systems work. The accuracy and cost of smoke testing is low compared to dye testing, which is lower than video inspection. Be careful; smoke testing will verify connectivity but not flow direction. Video inspection is recommended for best accuracy and is the only method that will help to evaluate the condition of the system, including cross connections and potential infiltration from groundwater.

- **Identify potential pollutant sources**. Conduct a detailed inspection of the facility to identify potential pollutant sources. Research products in building materials and products used at the facility. Material Safety Data Sheets (MSDS) may be available for some products. Take note of high traffic areas, vehicle and equipment storage and fueling areas, metal products and building materials (especially galvanized products), and paints/coatings used at the facility. Evaluate where stormwater draining from these areas enters the drainage system.

- **Select source characterization sampling locations**. Prepare a sampling plan to sample stormwater at key points and junctures of the drainage system, upstream from the location where samples are collected to assess ISGP compliance. Prioritize areas with the highest concentrations of pollutants or where sources are not well known.

- **Sampling and analysis (total/dissolved; particle size, etc.)**. Implement a comprehensive sampling program. The more sampling that is performed, the better the understanding of the pollutant sources and variability. Consider analysis of selected samples for additional parameters, such as total and dissolved metals and particle size, which can assist with source identification and BMP selection.

- **Review data/evaluate further sampling**. Review laboratory data and consider additional sampling over time to evaluate trends and/or additional upstream sampling to better identify sources.

Appendix E

Facility-Specific Evaluations

Appendix E: Facility-Specific Evaluations

TABLE E-1

WASHINGTON STATE MARINE TERMINAL STORMWATER TREATMENT COST COMPARISON

	Project Location	MARINE TERMINAL X Conceptual Alternative			MARINE TERMINAL X Selected Alternative			MARINE TERMINAL X Screened Alternative			MARINE TERMINAL X Screened Alternative			MARINE TERMINAL X Screened Alternative			MARINE TERMINAL X Screened Alternative		
	Treated Area (ac)																		
	No. of Outfalls																		
	Treatment Approach																		
	Pumped or Gravity Fed																		
	Flow rate (gpm)																		
	Work Areas																		
	Paving																		
	Groundwater/Dewatering																		
	Dewatering Water Treatment																		
	Shoring																		
	Excavated Material Assumptions																		
	Backfill Materials Assumptions																		
	Cost Basis/Estimate Level																		
Work Items:																			
1	Div. 1 Costs including mobilization, demobilization, bonds, insurance, surveying, safety, temporary erosion and sediment control, temporary barricades & fencing		LS			LS			LS			LS			LS			LS	
2	Temporary stormwater bypass pumping		LS			LS			LS			LS			LS			LS	
3	Site prep including pavement removal, disposal, demolition of existing, reroute existing		LS			LS			LS			LS			LS			LS	
4	Excavation including hauling & disposal		CY			CY			CY			CY			CY			CY	
5	Shoring		SF			SF			SF			SF			SF			SF	
6	Backfill-using imported materials		CY			CY			CY			CY			CY			CY	
7	Dewatering including filtration		LS			LS			LS			LS			LS			LS	
8a	Treatment System: Passive System (including structure, media, internals, etc.) and installation		EA			EA			EA			EA			EA			EA	
8b	Treatment System: Active System (including foundation, electrical, etc.) and installation		EA			EA			EA			EA			EA			EA	
9	Intercept existing drainage piping/manholes and connection to new piping systems		LC			LC			LC			LC			LC			LC	
10	Influent piping including trenching & bedding		LF			LF			LF			LF			LF			LF	
11	Effluent piping including trenching & bedding		LF			LF			LF			LF			LF			LF	
12	Other piping including trenching & bedding		LF			EA			EA			EA			EA			EA	
13	Manholes/diversion structures		EA			EA			EA			EA			EA			EA	
14	Lift stations including electrical		LS			EA			EA			EA			EA			EA	
15	Repaving disturbed areas including base materials		SY			SY			SY			SY			SY			SY	
16	Fencing/bollards		LF			LF			LF			LF			LF			LF	
17	Contaminated soil disposal (allowance)		CY			CY			CY			CY			CY			CY	
18	Additional drainage revisions		LS			LS			LS			LS			LS			LS	
	Subtotal																		
	Estimated Construction Cost (Sales Tax Excluded)																		
	Total Construction Cost/Acre Treated																		
	Average Acres/Outfall																		
	Total Constructed Cost/gpm Treatment Capacity																		

Note: Unit costs assumed to include contractor overhead and profit, estimating contingency, and escalation.

TABLE E-2

EXAMPLE WASHINGTON STATE MARINE TERMINAL STORMWATER TREATMENT COST COMPARISON

	Project Location	EXAMPLE MARINE TERMINAL Conceptual Alternative			EXAMPLE MARINE TERMINAL Selected Alternative			EXAMPLE MARINE TERMINAL Screened Alternative			EXAMPLE MARINE TERMINAL Screened Alternative			EXAMPLE MARINE TERMINAL Screened Alternative			EXAMPLE MARINE TERMINAL Screened Alternative		
	Treated Area (ac)	91 Acres			68 Acres (for this project)			91 Acres			91 Acres			91 Acres			91 Acres		
	No. of Outfalls	4			3			4			4			4			4		
	Treatment Approach	approach assuming 30% pollutant reduction			Proprietary Below Grade Media Filtration			Proprietary Above Grade Media Filtration			Above Grade Chitosan-Enhanced Sand Filtration (CESF)			Proprietary Above Grade Media Filtration			Above Grade Electrocoagulation		
	Pumped or Gravity Fed	Gravity			Gravity			Pumped (4 Lift Stations)			Pumped (4 Lift Stations)			Pumped (4 Lift Stations)			Pumped (4 Lift Stations)		
	Flow rate (gpm)	3950			2960			3950			3950			3950			3950		
	Work Areas	N/A			Constrained Area/Barricades Required/Work Hour Limitations			Constrained Area/Barricades Required/Work Hour Limitations			Constrained Area/Barricades Required/Work Hour Limitations			Constrained Area/Barricades Required/Work Hour Limitations			Constrained Area/Barricades Required/Work Hour Limitations		
	Paving	N/A			Existing Area Paved- 8" Asphalt Concrete			Existing Area Paved- 8" Asphalt Concrete			Existing Area Paved- 8" Asphalt Concrete			Existing Area Paved- 8" Asphalt Concrete			Existing Area Paved- 8" Asphalt Concrete		
	Groundwater/Dewatering	N/A			Extensive, Groundwater expected within excavations and trenches			Extensive, Groundwater expected within excavations and trenches			Extensive, Groundwater expected within excavations and trenches			Extensive, Groundwater expected within excavations and trenches			Extensive, Groundwater expected within excavations and trenches		
	Dewatering Water Treatment	N/A			Storage and treatment may be required			Storage and treatment may be required			Storage and treatment may be required			Storage and treatment may be required			Storage and treatment may be required		
	Shoring	N/A			Required to minimize excavation footprint			Required to minimize excavation footprint			Required to minimize excavation footprint			Required to minimize excavation footprint			Required to minimize excavation footprint		
	Excavated Material Assumptions	N/A			Material will be exported. Unsuitable but not regulated			Material will be exported. Some regulated			Material will be exported. Some regulated			Material will be exported. Some regulated			Material will be exported. Some regulated		
	Backfill Materials Assumptions	N/A			Clean imported materials			Clean imported materials			Clean imported materials			Clean imported materials			Clean imported materials		
	Cost Basis/Estimate Level	N/A			90% Design Engineer's Estimate			Preliminary Design Engineer's Estimate			Preliminary Design Engineer's Estimate			Preliminary Design Engineer's Estimate			Preliminary Design Engineer's Estimate		
Work Items:																			
1	Div. 1 Costs including mobilization, demobilization, bonds, insurance, surveying, safety, temporary erosion and sediment control, temporary barricades & fencing		LS		1	LS	245,210	1	LS	639,382	1	LS	690,690	1	LS	699,899	1	LS	891,977
2	Temporary stormwater bypass pumping		LS		1	LS	86,907	1	LS	42,099	1	LS	42,099	1	LS	42,099	1	LS	42,099
3	Site prep including pavement removal, disposal, demolition of existing, reroute existing		LS		1	LS	52,179	1	LS	86,486	1	LS	86,486	1	LS	83,727	1	LS	85,106
4	Excavation including hauling & disposal		CY		2,867	CY	238,028	939	CY	12,349	939	CY	12,349	939	CY	12,349	939	CY	12,349
5	Shoring		SF		23,240	SF	261,023	5,120	SF	148,189	5,120	SF	148,189	5,120	SF	148,189	5,120	SF	148,189
6	Backfill-using imported materials		CY		3,521	CY	233,853	1,125	CY	36,442	1,125	CY	36,442	1,125	CY	36,442	1,125	CY	36,442
7	Dewatering including filtration		LS		1	LS	73,750	1	LS	65,780	1	LS	65,780	1	LS	65,780	1	LS	65,780
8a	Treatment System: Passive System (including structure, media, internals, etc.) and installation	1,000	EA	1,000,000	3	EA	876,422	4	EA	2,458,710				4	EA	3,232,868			
8b	Treatment System: Active System (including foundation, electrical, etc.) and installation										4	EA	3,103,354				4	EA	5,625,783
9	Intercept existing drainage piping/manholes and connection to new piping systems				3	LC	136,557												
10	Influent piping including trenching & bedding		LF		334	LF	62,146	720	LF	100,347	720	LF	110,497	720	LF	110,497	720	LF	110,497
11	Effluent piping including trenching & bedding		LF					720	LF	110,879	720	LF	110,879	720	LF	110,879	720	LF	110,879
12	Other piping including trenching & bedding		LF			EA													
13	Manholes/diversion structures		EA		12	EA	194,653												
14	Lift stations including electrical		LS		0	EA		4	EA	2,404,285	4	EA	2,404,285	4	EA	2,404,285	4	EA	2,404,285
15	Repaving disturbed areas including base materials		SY		2,069	SY	222,272	3,271	SY	313,121	3,271	SY	313,121	3,093	SY	296,103	3,182	SY	304,612
16	Fencing/bollards							720	LF	181,290	720	LF	181,290	720	LF	181,290	720	LF	181,290
17	Contaminated soil disposal (allowance)		CY			CY		3,499	CY	414,256	3,499	CY	414,256	3,499	CY	414,256	3,499	CY	414,256
18	Additional drainage revisions							1	LS	242,946	1	LS	242,946	1	LS	242,946	1	LS	242,946
	Subtotal			1,000,000			2,683,001			7,256,562			7,962,664			8,081,610			10,676,491
	Sales Tax				0.00%		-	0.00%		-	0.00%		-	0.00%		-	0.00%		-
	Estimated Construction Cost			**1,000,000**			**2,680,000**			**7,260,000**			**7,960,000**			**8,080,000**			**10,680,000**
	Total Construction Cost/Acre Treated			$ 11,000			$ 39,000			$ 80,000			$ 87,000			$ 89,000			$ 117,000
	Average Acres/Outfall			22.8			22.7			22.8			22.8			22.8			22.8
	Total Constructed Cost/gpm Treatment Capacity			$ 253			$ 905			$ 1,838			$ 2,015			$ 2,046			$ 2,704
	Adjustment for Median Bid Price			-	14%		1,032	0.00%		-	0.00%		-	0.00%		-	0.00%		-

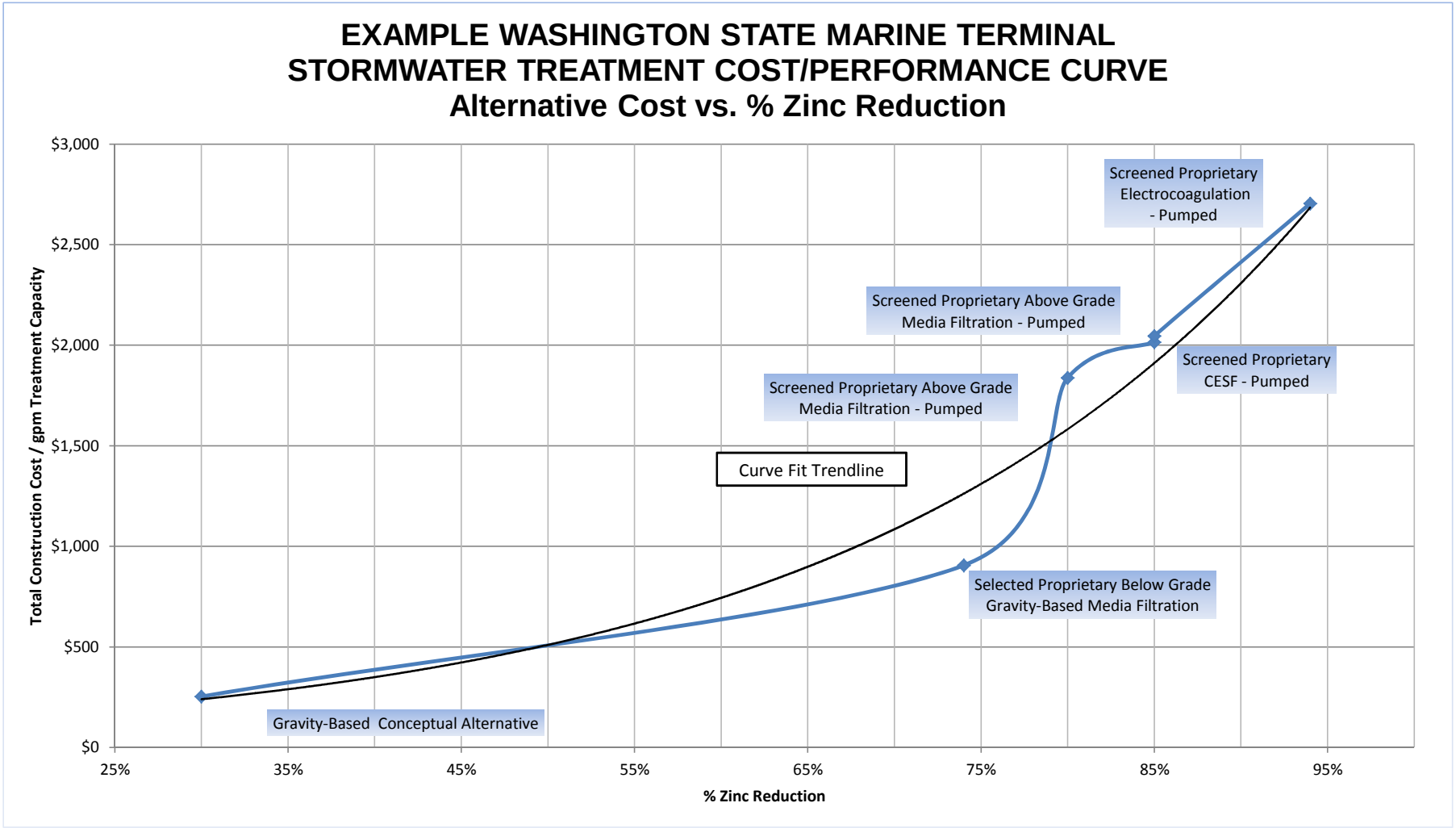
Notes: * Unit costs include the following costs included in the engineer's opinion of probable project cost: contractor overhead and profit, 5% estimating contingency, and 10% escalation.
* Estimates do not include design fees, construction management costs, engineering fees during construction, and costs for system operation and maintenance.

TABLE E-3

CASE STUDY WASHINGTON STATE MARINE TERMINAL STORMWATER TREATMENT COST SUMMARIES

	Project Location	PORT OF TACOMA OCT Selected Alternative			PORT OF TACOMA NIM			PORT OF TACOMA SIM			PORT OF TACOMA LOGYARD Selected Alternative			NORTHLAND SERVICES[a] PORT OF SEATTLE T115 Selected Alternative			PORT OF OLYMPIA[a] MARINE TERMINAL Selected Alternative		
	Treated Area (ac)	45 Acres			11 Acres			16 Acres			25 Acres			44 Acres					
	No. of Outfalls	5			1			2			2			2					
	Treatment Approach	Proprietary Below Grade Media Filtration			Proprietary Above Grade Media Filtration			Proprietary Below Grade Media Filtration			Above Grade Biofiltration			Above Grade CESF					
	Pumped or Gravity Fed	Gravity			Gravity			Gravity			Pumped (2 lift stations)			Pumped (2 Lift Stations)					
	Flow rate (gpm)	1840			465			670			1020			1925					
	Work Areas	Constrained Area/Barricades Required/Work Hour Limitations			Constrained Area/Barricades Required/Work Hour Limitations			Constrained Area /Barricades Required/ Work Hour Limitations			Accessible/Minimal Work Restrictions			Constrained Area/Constrained Schedule					
	Paving	Existing Area Paved- 8" Asphalt Concrete			None			Existing Area Paved- Up to 24" Asphalt Concrete			Existing Area Paved- 4" Asphalt Concrete			Existing Area Paved- 6" Asphalt Concrete					
	Groundwater/Dewatering	Extensive, Groundwater expected within excavations and trenches			Extensive, Groundwater expected within excavations and trenches			Extensive, Groundwater expected within excavations and trenches			Minimal, Groundwater expected below base of excavations			Extensive, Groundwater expected within excavations and trenches					
	Dewatering Water Treatment	Minimal- Filtration only			Storage and treatment may be required			Minimal- Filtration only			Minimal- Filtration only			Minimal - Filtration only					
	Shoring	Required to minimize excavation footprint			Required to minimize excavation footprint			Required to minimize excavation footprint			Optional, trench boxes or open cut			footprint					
	Excavated Material Assumptions	Material will be exported. Unsuitable but not regulated			Material will be exported. Some regulated			Material will be exported. Unsuitable but not regulated			Material will be exported. Some regulated			Material will be exported. Unsuitable but not regulated					
	Backfill Materials Assumptions	Clean imported materials			Clean imported materials			Clean imported materials			Cleam imported material for below structures only			Clean imported materials					
	Cost Basis/Estimate Level	Final Design Engineer's Estimate			Final Design Engineer's Estimate			Final Design Engineer's Estimate			Final Design Engineer's Estimate								
Work Items:																			
1	Div. 1 Costs including mobilization, demobilization, bonds, insurance, surveying, safety, temporary erosion and sediment control, temporary barricades & fencing	1	LS	139,062	1	LS	55,649	1	LS	99,287	1	LS	199,906		LS			LS	
2	Temporary stormwater bypass pumping	5	LS	24,440	1	LS	4,888	2	LS	9,776	1	LS	9,776		LS			LS	
3	Site prep including pavement removal, disposal, demolition of existing, reroute existing	5	LS	23,581	1	LS	0	1	LS	12,542	1	LS	41,047		LS			LS	
4	Excavation including hauling & disposal	862	CY	42,843	403	CY	9,841	541	CY	13,223	5,253	CY	32,097		CY			CY	
5	Shoring	5,380	SF	180,136	1,780	SF	59,599	2,707	SF	107,177		SF			SF			SF	
6	Backfill-using imported materials	916	CY	471	499	CY	21,625	631	CY	27,130	2,739	CY	95,355		CY			CY	
7	Dewatering including filtration	5	LS	91,649	1	LS	36,660	2	LS	48,880	1	LS	48,880		LS			LS	
8a	Treatment System: Passive System (including structure, media, internals, etc.) and installation	5	EA	392,381	2	EA	158,859	2	EA	203,108		SF	1,435,033		EA			EA	
8b	Treatment System: Active System (including foundation, electrical, etc.) and installation		EA			EA			EA						EA			EA	
9	Intercept existing drainage piping/manholes and connection to new piping systems	5	LC	100,307	1	LC	43,836	2	LC	46,738					LC			LC	
10	Influent piping including trenching & bedding										703	LF	53,409		LF			LF	
11	Effluent piping including trenching & bedding										596	LF	48,639		LF			LF	
12	Other piping including trenching & bedding	5	EA	9,165	1	EA	3,788	2	EA	3,666	1,460	LF	115,522		EA			EA	
13	Manholes/diversion structures	0	EA	0	1	EA	14,053	4	EA	34,410	12	EA	71,364		EA			EA	
14	Lift stations including electrical	0	EA	0	0	EA		0	EA		2	LS	282,276		EA			EA	
15	Repaving disturbed areas including base materials	467	SY	42,821	0	SY	0	232	SY	50,005	2,189	SY	181,512		SY			SY	
16	Fencing/bollards				80	LF	4,888								LF			LF	
17	Contaminated soil disposal (allowance)	0	CY	0	707	TON	51,692	0	CY	0	1,325	CY	80,935		CY			CY	
18	Additional drainage revisions														LS			LS	
	Subtotal			1,046,856			465,379			655,941			2,695,751						
	Sales Tax	0.00%		-	0.00%		-	0.00%		-	0.0%		0			-			
	Estimated Construction Cost			**1,050,000**			**470,000**			**660,000**			**2,700,000**			**-**			
	Total Construction Cost/Acre Treated			$ 23,000			$ 41,000			$ 40,000			$ 108,000			$ -			$ -
	Average Acres/Outfall			9.0			11.4			8.3			12.5						
	Total Constructed Cost/gpm Treatment Capacity			$ 571			$ 1,011			$ 985			$ 2,647			$ -			
	Adjustment for Median Bid Price	0%		-	0%		-	0%		-	0%					-			

Notes: (a) Missing summary data currently not available.
* Estimates do not include design fees, construction management costs, engineering fees during construction, and costs for system operation and maintenance.
* Blank quantities and costs will be updated following bid selection.



Notes: * Construction cost/gpm treatment capacity from Table E-2 (Appendix E)
* % Zinc Reduction based on values for proprietary stormwater treatment approaches listed in Table C-1 (Appendix C)